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Arizona Corporation Commission
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December 30, 2016

Docket Control
Arizona Corporation Commission
1200 W. Washington Street
Phoenix, AZ 85007

RE: Arizona Public Service Company's (APS) Technical Reference Manual For Energy Efficiency Programs
Docket No. E-01345A-11-0224

In Decision No. 73183 (May 24, 2012), APS is required to:

> APS shall compile and make available to all parties of the docket a technical reference manual documenting program and measure savings assumptions and incremental costs no later than December 31, 2013. This manual would be updated on an annual basis as part of the DSM implementation plan process and would serve as a reference tool for the LFCR analysis. *Decision No. 73183, Exhibit A, paragraph 9.15.*

Attached, please find APS's updated Technical Reference Manual for APS Energy Efficiency Programs. The manual has been updated to add the additional measures that were approved in Decision No. 75323 (November 25, 2015), as well as update algorithm input values for existing measures based on Measurement, Evaluation and Research (MER).

If you should have any questions regarding the information contained herein, please contact me at 602-250-3341.

Sincerely,

Kerri C

Kerri Carnes

KC/ks
Attachments

Cc: Barbara Keene

NAVIGANT

Technical Reference Manual for APS Energy Efficiency Programs

Program Year 2016

Prepared for:

Arizona Public Service Company

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December 30, 2016

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1. INTRODUCTION

1.1 Purpose of the TRM

This Technical Reference Manual (TRM) required by the Arizona Corporation Commission (ACC) in Decision No. 73183, page 14; as well as in Section 9.15 of the Settlement Agreement states, "Arizona Public Service's (APS) shall compile and make available to all parties of the docket a technical reference manual documenting program and measure savings assumptions and incremental costs no later than December 31, 2013. This manual would be updated on an annual basis as part of the Demand Side Management (DSM) implementation plan process and would serve as a reference tool for the Lost Fixed Cost Recovery (LFCR) analysis." The original version of this TRM was filed on December 23, 2013. This version was updated in December of 2016 to include updated algorithm input values for existing measures based on Measurement, Evaluation and Research (MER). This version also includes updates for the following additional measures as approved in the ACC Decision No. 75679 on August 5, 2016:

- **Smart Thermostats** for the Consumer Products and Solutions for Business programs
- **Western Cooling Control** for the Existing Residential HVAC and Solutions for Business programs
- **Behavioral Demand Response** component of the Residential Behavioral program
- **Linear Light Emitting Diodes (LEDs)** for the Solutions for Business programs
- **Electrically Commutated Motors for HVAC Applications** for the Solutions for Business programs

Therefore, the TRM not only documents all program and measure savings assumptions and incremental costs for the APS portfolio of Energy Efficiency programs, but also per the directive given:

- Provides a common reference for all stakeholders regarding energy and demand savings assumptions, calculations, incremental costs and their underlying sources.
- Serves as a tool for identifying areas of uncertainty to be addressed via evaluation efforts and/or other targeted end-use studies.
- Provides APS with a reference tool for its LFCR analysis.

The TRM will be updated as part of future DSM implementation plans to reflect changes in savings and incremental cost assumptions based on MER findings and annual variations in program activity. The savings and costs presented here are specific to program year 2016.

1.2 Development Process

The measure characterizations and associated savings presented here are based on standard engineering algorithms and models calibrated to APS's programs. Input values to these algorithms and models are derived from APS program implementation tracking data and extensive measurement and evaluation research activities including field metering studies, performance testing, building simulation, billing analyses, secondary literature reviews, and trade ally and customer surveys, focus groups and Delphi panels. The values identified in this TRM have been aggregated and summarized to represent average savings at the measure level. All input assumptions are based on APS or Arizona-specific data, where available, or from nearby regions with similar climates.

1.3 Update Process

APS will provide an updated TRM reflecting all adjustments made as part of any future DSM implementation plan, as approved by the Commission. Any MER findings resulting in adjustments to measure level savings or cost assumptions will be reviewed with APS and formalized in an evaluation issues memo. The TRM and supporting MAS will then be updated to reflect these MER findings. All adjustments reflected in the TRM will be used from that point forward and will not be applied retroactively to previously reported energy or demand reductions. For measures where assumptions are adjusted mid-year, and thus annual savings calculated are based on two sets of assumptions, the TRM will reflect the most recent adjustments.

1.4 Using the TRM

Each chapter in the TRM pertains to a specific EE program, with residential programs presented first, followed by commercial programs. For programs with measures addressing multiple end-uses, the chapter is sub-divided by those end-uses. For instance, the Consumer Products Program addresses both residential lighting and pool pump end-uses. Therefore, the first part addresses lighting and the second follows pools. Each end-use is further broken down into the following parts:

- ***Algorithm Input Descriptions*** – this section defines the terms used as inputs to the engineering algorithms and models used to derive savings. Such terms include operation hours, efficiency ratings, capacities and sizes, and savings or adjustment factors. This section also provides a description of the source and analysis method used to derive values for the specific inputs.
- ***Measure Characterization*** - this section lists all assumptions and algorithms that support the savings and incremental costs for all measures within the APS portfolio of EE Measures. The parameters for calculating savings and incremental costs are listed in the same order for each measure in order to maintain a similar appearance for all of the measure characterization pages. See section 1.5for further details on the measure characterization section.
- ***Algorithm Input Values*** – this section provides numerical values in tabular format for incremental costs and all algorithm inputs used to estimate savings. The values provided in this section represent average estimates reflective of total program participation and account for variation in site-specific savings estimates. Site-specific savings can be estimated by applying site-specific factors, such as equipment capacity, efficiency, building type, operation hours, etc. to the engineering algorithms identified in the measure characterization section.

For measures shared among programs, a full measure characterization will be provided under the program the measure was initially filed under. This section will be referenced in chapters for programs that also offer this measure. For instance, the duct test and repair measure is offered by both the Existing Residential HVAC (ResHVAC) and Home Performance with Energy Star® (HPwES) programs. Since this measure was initially filed under the former, the full measure characterization is presented under ResHVAC, and referenced in the HPwES chapter. Any variations in assumptions for supporting programs will be noted and addressed under the program's specific chapter.

All information is presented on a per-measure basis. In using the measure-specific information in the TRM, it is helpful to keep the following notes in mind.

- Primary estimates of energy (kWh) and coincident peak demand (kW) savings are for first-year savings.
- Lifetime energy savings can be calculated by multiplying first-year energy savings by the measure effective useful lifetime.
- Unless otherwise noted, effective useful lifetime is defined as the estimated length of time - in years – savings are expected to persist.
- Measure characterizations and savings estimates are "at the customer meter" and do not include line losses or capacity reserve margins. Use the following equations to calculate "at the generator" savings:

Equation 1-1. Energy Savings at the Generator

$$\Delta kWh_{gen} = \Delta kWh_{meter} * (1 + LLF_{energy})$$

Where:

ΔkWh_{gen}	= Energy savings at the generator
ΔkWh_{meter}	= Energy savings at the meter
LLF_{energy}	= Line Loss Factor for energy (7.0%)

Equation 1-2. Demand Savings at the Generator

$$\Delta kW_{gen} = \Delta kW_{meter} * (1 + LLF_{demand}) * (1 + CRM)$$

Where:

ΔkW_{gen}	= Demand savings at the generator
ΔkW_{meter}	= Demand savings at the meter
LLF_{demand}	= Line Loss Factor for demand (11.7%)
CRM	= Capacity Reserve Margin (15%)

1.5 Measure Characterization

Each measure is characterized using the following sections. The following section defines the information provided in each section. The measure characterization is meant to provide aggregated, average values that support the MER verified savings.

Applicability –Defines the measure as one of the following options: *retrofit, early-retirement, replace-on-burnout, or new construction*. The applicability serves as the basis for defining the appropriate baseline and deriving incremental costs.

Applicable Programs – Defines which programs offer incentives for a given measure and for which the measure characterization is applicable.

Measure Description – Describes the measure technology and targeted end-use.

Baseline Equipment Definition – Defines the baseline condition used to estimate savings based on the applicability of the measure:

- *New Construction (NC):* Baseline is defined as the minimum specifications under federal, state or jurisdictional energy code.
- *Replace on Burnout (ROB):* Baseline is defined as the least-cost, minimum standard efficiency equipment that could be installed to replace working equipment.
- *Retrofit (RET):* Baseline is defined as the existing, operational equipment for the effective useful life of the measure.
- *Early Retirement (ER):* Baseline is defined as the existing, operational equipment for the remaining useful life of existing equipment and the least cost, minimum standard efficiency equipment for the remainder of the effective useful lifetime of the measure.

Energy Efficient Equipment Definition – Defines the criteria that qualify equipment for program rebates. Energy efficient specifications are often benchmarked to an energy efficiency specification, and are modified to meet changing codes and efficiency standards.

Unit Basis – Defines the unit on which savings and incremental costs are normalized for a given measure. For example, savings for a high efficiency air conditioner may be on either a "per unit" or "per ton" or "per kBtuh" basis.

Effective Useful Life (EUL) – Estimate of the number of years that the measure installed is still in place and operable. The EUL for each measure are determined from industry standard resources such as ENERGY STAR, Database for Energy Efficiency Resources (DEER), American Council for an Energy-Efficient Economy (ACEEE), primary research projects, or actual historical project details collected by the utility and verified through the MER process.

Measure Cost – Measure costs consist of equipment/material, installation and removal (less salvage value) costs paid by the participant, prior to the rebate. In addition, additional or deferred Operational and Maintenance (O&M) costs are considered in the estimate of measure cost. Estimates of measure costs are determined from various industry standard resources such as ENERGY STAR®, the California Energy Commission and California Public Utilities Commission sponsored DEER, ACEEE, primary research projects, or actual historical project details collected by the utility and verified through the MER activities. Measure cost basis is often defined as either a) incremental or b) full installed as defined below:

- *Incremental:* Defined as the difference in material costs between the baseline and efficient equipment. Installation and removal costs are assumed to be equal for the baseline and efficient case and therefore are not considered a cost to the participant. The incremental costs basis is typically applied for ROB and NC scenarios.
- *Full Installed:* Defined as the cost of the efficient equipment including labor and removal costs (if applicable) of the existing equipment. The full installed cost basis is typically applied for RET and ER scenarios. For ER scenarios, the measure cost is often discounted for the eventual replacement of the existing equipment with baseline equipment at the end of its remaining useful life.

Annual Energy Savings Algorithm – The algorithm used to estimate annual energy savings at the customer meter in kilowatt-hours (kWh) for the measure.

Coincident Peak Demand Savings Algorithm – The algorithm used to estimate coincidence peak demand savings at the customer meter in kilowatts (kW) for the measure.

2. CONSUMER PRODUCTS PROGRAM

APS's Consumer Products Program has two components. The program promotes both energy efficient lighting and energy efficient pool operations in the residential sector.

2.1 Residential Efficient Lighting

2.1.1 Algorithm Input Descriptions

2.1.1.1 Residential and Commercial Split

This factor accounts for a portion of program bulbs purchased by commercial customers and installed in commercial applications A study by Puget Sound Energy (PSE)[1] estimated that 92% of bulbs are purchased by residential customers, and 8% by commercial customers.

Savings for CFLs are calculated using a weighted average for each input value based on this 92%/8% residential/commercial split. For LEDs, the values reflect residential operation parameters only (i.e. a residential /commercial split of 100%/0%), assuming LED sales are largely influenced by early adopters and likely do not have a substantial commercial presence. This impact affects hours of operation, coincidence factor, demand interaction and energy interaction factors, as well as effective useful life.

2.1.1.2 Hours of Operation (OpHrs)

Hours-of-operation is the average number of hours annually that a participant CFL or LED is on. The value in Table 2-3 is derived from a 2014 field metering study and general population survey. The metering study resulted in average operating hours by space type. The general population survey resulted in the general distribution of participant CFLs and LEDs across space types. The final operating hours utilized is the average of the space type specific hours weighted by the distribution of CFLs and LEDs across those space types.

Annual hours of operation is listed in Section 2.1.3.

2.1.1.3 Coincidence Factor (CF)

The Coincidence Factor (CF) is the fraction of program participants' peak demand savings occurring during APS' system peak. The values for CFLs and LEDs in Table 2-3 come from a 2014 field metering study and general population survey, and an analysis of APS's system load.

The CF is presented in Section 2.1.3.

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[1] PSE-Itron, 2014-2015 Residential Retail Lighting Impact Evaluation.

2.1.1.4 In-Service Rate (ISR)

The In-Service Rate (ISR) refers to the percent of incentivized bulbs that are installed and operational at a given time. The values for CFLs and LEDs in Table 2-3 come from a 2014 field metering study and general population survey.

The ISR is presented in Section 2.1.3.

2.1.1.5 Leakage Rate (LR)

The Leakage Rate (LR) refers to the percent of bulbs that are incentivized through the program, but installed outside of APS's service territory. A leakage rate analysis was conducted in 2009 on all participating retailers. This analysis used U.S. Census data in combination with retailer location to determine the likely proportion of APS and non-APS customers per participating retail location.

The LR is presented in Section 2.1.3.

2.1.1.6 Demand Interaction Factor (DIF)

The Demand Interaction Factor (DIF) accounts for interactive effects between lighting demand and HVAC demand so that the CFL and LED demand savings are the savings at the light source in addition to any electrical savings at the cooling system and less any increase in electrical demand at the heating system. Residential simulation modeling was used to determine the DIF.

The DIF is listed in Section 2.1.3.

2.1.1.7 Energy Interaction Factor (EIF)

The Energy Interaction Factor (EIF) accounts for interactive effects between lighting energy consumption and HVAC energy consumption so that the CFL and LED energy savings are the savings at the light source in addition to any electrical savings at the cooling system and less any increase in electrical energy consumption at the heating system. Residential simulation modeling was used to determine the EIF.

The EIF is listed in Section 2.1.3.

2.1.2 Measure Characterization

2.1.2.1 Applicability

Replace on Burnout

2.1.2.2 Applicable Programs

This measure is applicable to the Consumer Products Program.

2.1.2.3 Measure Description

This lighting end-use measure promotes energy efficient residential lighting. CFLs and LEDs offer a longer effective useful life than other similar lighting sources and use less energy to produce a comparable amount of light.

2.1.2.4 Baseline Equipment Definition

The baseline lighting source is an incandescent or halogen bulb, where the baseline wattage is specific to the efficient lamp type.

Baseline values reflect both federal efficacy standards (Energy Independence and Security Act of 2007 and DOE's 2009 rulemaking) and the market availability of bulbs that do not meet these standards. Baseline calculations are based on analyses presented in a U.S. Environmental Protection Agency report on next generation lighting programs[2].

The base wattages corresponding to specific CFL and LED lamp types are provided in Section 2.1.3for 2013.

2.1.2.5 Efficient Equipment Definition

The efficient case refers to Energy Star® certified compact fluorescent lamps and light emitting diodes ranging from 6 watts through 68 watts.

The efficient wattage corresponding to specific CFL and LED lamp types are provided in Section 2.1.3.

2.1.2.6 Unit Basis

This measure's incentive, savings, and incremental measure cost are determined on a "per lamp" basis.

2.1.2.7 Effective Useful Life

CFLs have an effective useful life of 5 years based on manufacturing specifications, an estimate of hours of use per day accounting for the 92% residential and 8% commercial split, secondary literature[3] and an 82% in-service rate (ISR).

LEDs have an effective useful life of 15 years based on ENERGY STAR recommendations effective at the time the MAS sheet was created (e.g., minimum of 25,000 hours per bulb), an ISR of 95% and an estimate of hours of use per day. Daily hours of use are drawn from the lighting-specific loadshape based on metered data for APS service territory.

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[2] United State Environmental Protection Agency. "Next Generation Lighting Programs: Opportunities to Advance Efficient Lighting for a Cleaner Environment."

[3] Survival Analysis of SCE/CPUC CFL Lab Study. Brett Close, June 4, 2015. http://www.calmac.org/publications/CFL_Lab_Study.pdf

2.1.2.8 Incremental Measure Cost

The incremental cost varies with lamp wattage. The efficient and baseline costs are weighted averages of CFL, LED, halogen and incandescent bulb costs across manufacturers collected on-site at participating retailers and on-line.

Specific incremental costs can be found in Section 2.1.3.

2.1.2.9 Energy Savings Algorithm

$$\Delta kWh = \frac{(W_{base} - W_{ee})}{1000} \times OpHrs \times ISR \times (1 - LR) \times (1 + EIF)$$

Where:

ΔkWh	=	Energy savings for measure (in kWh)
W_{base}	=	Baseline Wattage of Fixture
W_{ee}	=	Efficient Wattage of Fixture
OpHrs	=	Hours of Operation
ISR	=	In-Service Rate
LR	=	Leakage Rate
EIF	=	Energy Interaction Factor

2.1.2.10 Coincident Peak Demand Savings Algorithm

$$\Delta kW_{coincident} = \frac{(W_{base} - W_{ee})}{1000} \times CF \times ISR \times (1 - LR) \times (1 + DIF)$$

Where:

$\Delta kW_{coincident}$	=	Coincident peak demand savings for this measure (in kW)
W_{base}	=	Baseline Wattage of Fixture
W_{ee}	=	Efficient Wattage of Fixture
CF	=	Coincidence Factor
ISR	=	In-Service Rate
LR	=	Leakage Rate
DIF	=	Demand Interaction Factor

2.1.2.11 Bulbs Installed From Storage Algorithm

This measure includes an estimate of annual savings for bulbs from previous program years that were placed in storage. As mentioned above, the annual savings algorithm for program bulbs includes an in-service adjustment which de-rates savings based on a portion of bulbs being placed in-storage. (See section 2.1.1.4 for more details). These "in-storage" bulbs are assumed to be installed over the next three years, and contribute to the annual savings goals claimed. The Uniform Methods Project (UMP) recommends the algorithm below to account for savings from these bulbs as they come out of storage and are placed in service during the successive three years. Under the UMP approach, the largest proportion of bulbs are assumed to come out of storage the first, year, fewer the second year, and fewer the third year. The algorithm assumes a small percentage of bulbs are never removed from storage. Table 2-1 and Table 2-2 present the methodology which is used to calculate three year in-service rates for CFLs and LEDs. Total storage is calculated using the following equation:

$$\Delta kWh_{storage;yr} = \sum_{t=1}^{3} \left(\%Is \cdot \frac{\Delta kWh_{Total}}{ISR} \cdot (1 - ISR)\right)_{yr-t}$$

Where:

$\Delta kWh_{storage;yr}$	=	Savings from bulbs coming out of storage
yr	=	Current program year
t	=	Number of years prior to current program year
ΔkWh_{Total}	=	Annual program savings from previous program years (yr-1, yr-2 and yr-3)
ISR	=	In-Service Rate from previous program years
$\%Is$	=	Percent of stored bulbs installed from previous program years (yr-1, yr-2 and yr-3)

Table 2-1. Estimated Three-Year In-Service Rate Calculations for CFLs

Year	Cumulative In-Service Rate—CFL	Percent Installed from Storage—CFL
Year 1	82.0%	
Year 2	89.4%	41%
Year 3	94.4%	28%
Year 4	97.0%	14%

Table 2-2. Estimated Three-Year In-Service Rate Calculations for LEDs

Year	Cumulative In-service Rate—LED	Percent Installed from Storage—LED
Year 1	95.4%	
Year 2	97.3%	41%
Year 3	98.6%	28%
Year 4	99.0%	9%

2.1.3 Algorithm Input Values

Table 2-3 presents the average operating parameters for lamps rebated through the Consumer Products Program. These reflect the residential/commercial splits discussed above.

Table 2-4 presents the baseline watts, efficient watts, and incremental costs for all lamps rebated through the Consumer Products Program.

Table 2-5 and Table 2-6 presents the algorithm inputs for calculating savings from lamps removed from storage and placed in service.

Table 2-3. Lighting Operating Parameters for the Consumer Products Program

Measure	OpHrs	CF	ISR	LR	DIF	EIF
CFLs	998	0.13	82%	6%	0.294	0.107
LEDs	986	0.08	95%	6%	0.303	0.102

Table 2-4. Efficient Wattages, Baseline Wattages, and Incremental Costs by Efficient Lamp Type

Bulb Type	Measures	Baseline W	Efficient W	Incremental Cost*
CFL	25 Watt replacements	25	5	$1.89
CFL	40 Watt replacements	29	9	$1.74
CFL	60 Watt replacements	43	13	$1.48
CFL	75 Watt replacements	53	19	$1.14
CFL	100 Watt replacements	72	23	-$0.29
CFL	PAR 38 replacements	70	24	$0.88
CFL	BR40 replacements	65	23	$2.44
CFL	125 Watt replacements	125	32	$7.20
CFL	150 Watt replacements	150	42	$5.96
CFL	200 Watt replacements	200	55	$12.45
CFL	300 Watt replacements	300	68	$13.57
CFL	3 way replacements	115	26	$8.78
CFL	11 Watt R20	45	11	$3.82
CFL	11 Watt R20 Dimmable	45	11	$1.80
CFL	14 Watt BR30	65	14	$0.74
CFL	15 Watt BR30	65	15	$0.74
CFL Giveaway	Weighted Average	59	19	$1.80
LED	100 Watt Replacement	72	16	$7.70

LED	75 Watt Replacement	53	14	$7.70
LED	60 Watt Replacement	43	10	$2.93
LED	40 Watt Replacement	29	5	$0.95
LED	PAR 38 Replacement	70	18	$7.70
LED	Exempt Bulbs	67	12	$7.70
LED Giveaway	Weighted Average	43	10	$1.44

**For both CFLs and LEDs, it is assumed that customers would purchase at least a baseline model bulb at the time of the purchase, so the retail cost of a CFL and LED are calculated as the efficient cost less the baseline cost.*

Table 2-5. Algorithm Inputs for CFL Bulbs Removed and Installed from Storage

Program Year	t	ISR	[illegible]
2014	3	18%	13,399
2015	2	18%	11,269
2016	1	18%	12,352

Table 2-6. Algorithm Inputs for LED Bulbs Removed and Installed from Storage

Program Year	t	ISR	[illegible]
2014	3	0%	---
2015	2	4.6%	---
2016	1	4.6%	239

2.2 Variable Speed Pool Pumps

2.2.1 Baseline and Participant Pump Descriptions

Energy and demand savings for this measure are determined using metered energy data collected at single speed, dual speed, and variable speed pumps.

2.2.1.1 Single Speed Pumps

Single speed pumps are pumps that operate at one fixed speed and are typically controlled with a mechanical timer.

See Section 2.2.3for baseline weighting, average energy consumption, and average coincident demand.

2.2.1.2 Dual Speed Pumps

Dual speed pumps are pumps that operate at two fixed speeds and are commonly controlled with either a mechanical timer or a digital control system.

See Section 2.2.3for baseline weighting, average energy consumption, and average coincident demand.

2.2.1.3 Variable Speed Pumps

Variable speed pumps can operate at several flexible speeds and are commonly controlled with either an internal or external digital control system.

See Section 2.2.3 for participant variable speed pool pump's average energy consumption, coincident demand, and incremental cost.

2.2.2 Measure Characterization

2.2.2.1 Applicability

Replace on Burnout and New Construction

2.2.2.2 Applicable Programs

This measure is applicable to the Consumer Products Program.

2.2.2.3 Measure Description

This measure promotes energy efficient residential pool operations by incentivizing pool pumps that are capable of optimization, and training pool service professionals to optimize such pumps. Pool pumps serve two primary functions (daily-cleaning and daily-filtration). As described in the pump affinity laws, power demand increases exponentially with motor speed. Thus, reducing motor speed to the minimum speed required for pool cleanliness saves wasted energy.

A single speed pump is typically sized to meet the highest motor speed required for a given pool's characteristics. When the pump is serving other functions, energy is wasted. A dual speed pump is typically sized so that its highest setting meets the highest motor speed required for a given pool's characteristics. Because the settings are fixed, the two daily settings generally run at higher motor speeds than necessary and energy is wasted. Variable speed pumps, however, enable pool technicians to set a pool pump exactly to the lowest motor speed requirements for *both* the daily-cleaning and daily-filtration settings, thus saving wasted energy.

2.2.2.4 Baseline Equipment Definition

The Consumer Products Program's baseline condition for estimating savings is a blend between single speed (1/2) and dual speed (1/2) pool pumps. While the current appliance standards in Arizona indicate a dual speed baseline, market research indicates that new and majorly renovated single speed pumps are available[4].

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[4] Navigant's market research in 2014 determined that 1/2 of APS customers are complying with Arizona's pool pump appliance standard, which mandates that customers purchase dual speed or variable speed pumps when replacing primary pool pumps. The other 1/2of customers are purchasing new single speed pumps or repairing existing single speed pumps for primary pool operations. This blend is expected to be 1/2 single speed pumps and 1/2 dual speed pumps in 2015 as customers comply with the standard.

See Section 2.2.3for specific values. See Sections 2.2.3and 2.2.1.2for more information on single and dual speed pumps.

2.2.2.5 Efficient Equipment Definition

The efficient case refers to variable speed pool pumps incentivized through the Consumer Products Program.

See Section 2.2.3 for specific values. See Section 2.2.1.3for more information on variable speed pool pumps.

2.2.2.6 Unit Basis

This measure's incentive, savings, and incremental measure cost are determined on a "per pump" basis.

2.2.2.7 Effective Useful Life

This measure has an effective useful life of 12 years based on interviews with manufacturers, retailers, and pool service professionals[5].

2.2.2.8 Incremental Measure Cost

The incremental cost for efficient pumps accounts for the difference in up-front costs as well as the difference in maintenance costs between efficient and baseline pumps. Up-front cost data was collected in stores in Arizona in 2013. Maintenance cost data was collected through interviews with pool service professionals located around the Phoenix area in 2013[6].

See Section 2.2.3 for specific values.

2.2.2.9 Annual Energy Savings Algorithm

Energy savings for this measure are determined using metered energy data collected at baseline and participant pumps.

The following algorithm is used to estimate annual energy saving impacts from this measure.

$$\Delta kWh = W_{ss} \times kWh_{ss} + W_{ds} \times kWh_{ds} - kWh_{vs}$$

Where:

[5] Navigant interviewed pool pump manufacturers, and retailers and service professionals located in the Phoenix area during the summer of 2013. Costs, maintenance differences, and other data were collected during these interviews.

[6] Navigant interviewed pool pump manufacturers, and retailers and service professionals located in the Phoenix area during the summer of 2013. Costs, maintenance differences, and other data were collected during these interviews.

ΔkWh	= Energy savings for this measure (in kWh)
W_{SS}	= Baseline weighting for single speed pumps
kWh_{SS}	= Average annual energy consumption of a single speed pump
W_{DS}	= Baseline weighting for dual speed pumps
kWh_{DS}	= Average annual energy consumption of a dual speed pump
kWh_{VS}	= Average annual energy consumption of a variable speed pump

2.2.2.10 Coincident Peak Demand Savings Algorithm

Demand savings for this measure are determined using metered data collected at baseline and participant pumps. The coincident demand for each pump type is estimated by spreading the average annual energy consumption evenly across the year (i.e. kWh/8760).

The following algorithm is used to estimate program impacts on coincident peak demand.

$$\Delta kW_{Coincident} = W_{SS} \times kW_{SS} + W_{DS} \times kW_{DS} - kW_{VS}$$

Where:

$\Delta kW_{coincident}$	= Coincident peak demand savings for this measure (in kW)
W_{SS}	= Baseline weighting for single speed pumps
kW_{SS}	= Average coincident peak demand of a single speed pump
W_{DS}	= Baseline weighting for dual speed pumps
kW_{DS}	= Average coincident peak demand of a dual speed pump
kW_{VS}	= Average coincident peak demand of a variable speed pump

2.2.3 Algorithm Input Values

Table 2-7 compares the average energy consumption, average coincident demand, and incremental cost between non-participant and participant pump types. These values are subject to change as more recent data is collected.

Table 2-7. Energy Consumption, Coincident Demand and Incremental Cost by Pump Type

Pump Type	Baseline Weighting	Annual Energy Consumption (kWh)	Coincident Demand (kW)	Incremental Costs (per unit)
Single Speed	1/2	4,813	0.55	-
Dual Speed	1/2	3,800	0.43	-
Variable Speed[7]	-	2,464	0.28	$478.65

[7] A 5% reduction is applied to the average variable speed pool pump energy consumption for 2013, as the meter data between pumps incentivized in 2011and pumps incentivized in 2012 indicates a trend of decreasing energy consumption in participant pumps as variable speed pool pump calibrations improve.

2.3 Smart Thermostats

2.3.1 Smart Thermostat Product Categories

This program includes a variety of smart thermostat models. To calculate savings, smart thermostats are assigned to three categories based on their energy saving features. These categories are listed below. Additional savings may be included as well for additional features such as Nest's Seasonal Savings program.

- Nest, Honeywell, and Ecobee
- EcoFactor and EnergyHub
- Other

2.3.2 Measure Characterization

2.3.2.1 Applicability

Retrofit

2.3.2.2 Applicable Programs

This measure is applicable to the Consumer Products Program.

2.3.2.3 Measure Description

This HVAC measure promotes the installation of smart thermostats. The incentive is determined on a per unit basis.

2.3.2.4 Baseline Equipment Definition

Baseline equipment for this measure is a non-programmable or basic programmable thermostat. The Consumer Products Program's baseline condition for estimating savings is a blend between non-programmable (35%) and basic programmable (65%) thermostats based on a 2015 NEST whitepaper[8].

2.3.2.5 Efficient Equipment Definition

Efficient equipment is a smart thermostat with WiFi-enabled two-way communication.

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[8] Energy Savings from the Nest Learning Thermostat: Energy Bill Analysis Results, Nest Whitepaper. 2015. https://nest.com/downloads/press/documents/energy-savings-white-paper.pdf

2.3.2.6 Unit Basis

This measure's savings and incremental measure cost are determined based on a "per unit" basis.

2.3.2.7 Effective Useful Life

This measure has an effective useful life of 10 years determined from professional judgment.

2.3.2.8 Energy Savings Factors

Energy savings factors refer to the percentage reduction in household energy use expected from each smart thermostat product. Energy savings factors for smart thermostats in this program are based on secondary research conducted on a broad range of smart thermostat models. Table 2-8 displays researched savings factors ("Savings Percent") for smart thermostat models relevant to this program.

Based on the available secondary research summarized above, we derive average expected savings factors for use in the program for each category of thermostat included in the program. These savings factors are listed in the Algorithm Input Descriptions section, in Table 2-8.

2.3.2.9 Coincidence Factor (CF)

The coincidence factor represents the percent of program thermostats contributing to demand savings during APS's system peak period. This analysis assumes a coincidence factor of 1.0 because the demand savings factor reflects savings during the system peak. This finding is based on results for a similar climate (e.g., southern California)[9,10].

2.3.2.10 Incremental Measure Cost

The incremental costs can be found in Table 2-10. Cost estimates are based on a review of thermostat costs from online sources.

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[9] Energy Savings from Nest: The Impact of the Nest Learning Thermostat, 2014, https://nest.com/downloads/press/documents/efficiency-simulation-white-paper.pdf

[10] Understanding Energy Efficiency Benefits from Smart Thermostats in Southern California, 2014, http://beccconference.org/wp-content/uploads/2014/12/presentation_Ho.pdf

Table 2-8. Energy Assumptions Sources

Model	Electricity (Mostly Cooling)		Cooling Demand Savings		Demand Response		Climate	Source
	Savings kWh	**Savings Percent**	**Savings kW**	**Savings Percent**	**Savings kW**	**Savings Percent**		
EcoFactor	585	13%	NA	NA	2.37 kW maximum	NA	NV	11
Nest	781	5%	NA	NA	NA	NA	OR	12
Nest	429	14%	NA	NA	NA	NA	IN	13
Nest	585	18%	NA	NA	NA	NA	US	14
Nest	423.4	11%	0.1 kW during 2-6pm on weekdays	NA	NA	NA	CA	15
Honeywell/ Opower	0	0%	NA	NA	NA	NA	CA	16
Nest	66	1%	NA	NA	0.44 kW - 0.69 kW	25% - 37%	NY	17
Ecobee, Nest	NA	13%	NA	NA	0.7 kW w/1-way; 1.6 kW w/2-way	NA	TX	18
Nest	NA	NA	NA	NA	1.18 kW	AC run time reduced by 55%	TX	19
EnergyHub	NA	14%	NA	NA	1.2 kW	NA	MN	20
EnergyHub, Nest	NA	6%	0.26 kW *from 2-7 pm on the average summer day*	NA	NA	NA	CA	21
EnergyHub	NA	NA	NA	NA	0.8 kW	NA	MN	22
Ecobee	104	16%	NA	NA	NA	NA	MA	23

[11] NV Energy mPowered Program. Technical Appendix, Volume 5 of 5.
[12] ETO Nest Thermostat Heat Pump Control Pilot Program Evaluation, Apex, 2014.
[13] Vectren Nest Evaluation of the 2013-2014 Programmable and Smart Thermostat Program; Cadmus, 2015.
[14] Nest, Energy Savings from the Nest Learning Thermostat: Energy Bill Analysis Results, 2015 White Paper.
[15] Nest, Energy Savings from Nest, The impact of Nest Learning Thermostat, 2014 White Paper.
[16] PGE&E, Opower/Honeywell Thermostat Trial Interim Findings, 2012.
[17] ComEd AC Cycling Pilot Program. Navigant, 2015.
[18] Austin Energy Power Partner Pilot; Seasonal Savings: Results from Summer 2013.
[19] CPS Energy Nest Rush Hour Rewards; CPS Energy Nest Pilot Evaluation FY2015 – Final. Nexant, 2014.
[20] CenterPoint Energy e5 DR Program Pilot Results; Earth Network.
[21] SCE Save Power Days Program; Seasonal Savings: Results from Summer 2013.
[22] Minnesota Valley Electric Cooperative Wifi Thermostat Project; Tech Surveillance; 2014.
[23] National Grid; Wi-Fi Programmable Controllable Thermostat Pilot Program Evaluation. Cadmus, September 2012.

2.3.2.11 Annual Energy Savings Algorithm

Savings for smart thermostats are based on secondary literature, as described in Section 0.

Savings factors for the energy algorithm are shown, by measure, in Table 2-9. Numeric values for the actual savings values are shown in Table 2-10.

The following algorithm is used to estimate annual energy saving impacts from this measure.

$$\Delta kWh = U_{size} \times kWh_{base} \times E_{model}$$

Where:

ΔkWh	= Energy savings for this measure (in kWh)
U_{size}	= Unit size (tons/thermostat)
kWh_{base}	= Baseline HVAC energy usage (kWh per ton)
E_{model}	= Energy savings factor by measure (%)

2.3.2.12 Coincident Peak Demand Savings Algorithm

Savings factors for the demand algorithm are shown, by measure, in Table 2-9. Numeric values for the actual savings values are shown in Table 2-10.

The following algorithm is used to estimate coincident peak demand saving impacts from this measure.

$$\Delta kW_{coincident} = kW \times CF$$

Where:

$\Delta kW_{coincident}$	= Coincident peak demand savings for this measure (in kW)
kW	= Non-coincident demand savings estimated from secondary literature
CF	= Coincidence factor

2.3.3 Algorithm Input Descriptions

2.3.3.1 Unit Size

The HVAC unit the thermostat is assumed to be controlling is 3.71 tons per thermostat. This value is based on the existing capacities sourced from the Residential HVAC program and reflects the typical unit size in APS territory.

2.3.3.2 Unit Efficiency

The assumed efficiency of the HVAC unit is a SEER 11.4, EER 10.0 air conditioner. This is the average efficiency for installed residential HVAC equipment based on the program data from the advanced diagnostic tune-up measure.

2.3.4 Algorithm Input Values

Table 2-9 shows the savings factors for the energy and demand algorithms by measure. Table 2-10 compares the average energy savings, average coincident demand savings, and incremental cost between the measure categories.

Table 2-9. Savings Factors for the Energy and Demand Algorithms by Measure

				Thermostat Model			
	Unit Size	Baseline HVAC Energy Use	Coincidence Factor	Nest, Honeywell, Ecobee	Other	EcoFactor, EnergyHub	Additional Smart Thermostat Features
Energy*	3.71	1407 kWh/ton	-	11.1%[10-13, 15, 16, 21]	7.5%	10.8%[9, 18, 19]	4.0%
Demand**	-	-	1.0	0.18 kW[13, 19]	0.18 kW[13, 19]	0.18 kW[13, 19]	0.067

** Energy savings are based on the various secondary sources available (see footnotes).*
***Demand savings are based on the two secondary sources available (see footnotes).*

Table 2-10. Energy Savings, Coincident Demand Savings, and Incremental Costs by Smart Thermostat Measure Type

Measure Type	Coincident Demand Savings (kW/unit)	Energy Savings (kWh/unit)	Incremental Cost ($/ton)
Smart Thermostat – Nest, Honeywell, Ecobee	0.18	581	120
Smart Thermostat – EcoFactor, Energy Hub	0.18	564	109
Smart Thermostat – Other Manufacturer	0.18	392	82
Additional Smart Thermostat Features (e.g. Nest's Seasonal Savings)[24]	0.07	209	85

[24] These savings should be added to the savings from the smart thermostat if additional features are included in the installation.

3. RESIDENTIAL HVAC

3.1 Algorithm Inputs

3.1.1 Average Unit Size

The average unit size represents the typical air conditioner or heat pump unit size for program participants. It is calculated as the weighted average of the capacity of all measure participants from 2012. For the Duct Test and Repair measure, the average unit size for manufactured homes was calculated using the weighted average of square footage per ton of cooling for all participants in APS's Home Performance with Energy Star program and the average square footage of manufactured homes from ES Contracting's manufactured home data.

3.1.2 Baseline Cooling Demand

The baseline demand is determined from a regression model based on 121 logged air conditioning units in APS territory in 2010. The baseline cooling demand is a function of average unit SEER and unit size.

The regression equation used to determine baseline cooling demand is

$$kW = (A - SEER) * C + D * (B - EER)$$

Where SEER and EER are the average efficiency rating of the program participants and the coefficients *A*, *B*, *C*, and *D* are listed in Table 3-1.

Table 3-1. Coefficients for Demand Regression Equation

System Efficiency	A	B	C	D
Single Stage (Below 13 SEER)	35.66	23.07	0.00	0.08
Single Stage (13-15 SEER)	30.00	36.94	0.00	0.03
Dual Stage (All over 15 SEER)	24.78	43.98	0.01	0.02

3.1.3 Baseline Cooling Energy

The baseline demand is determined from a model based on 121 logged air conditioning units in APS territory in 2010. The baseline cooling demand is a function of average unit SEER and unit size.

The regression equation used to determine baseline cooling demand is

$$kWh = (A - SEER) * C + D * (B - EER)$$

Where SEER and EER are the average efficiency rating of the program participants and the coefficients *A*, *B*, *C*, and *D* are listed in Table 3-2.

Table 3-2. Coefficients for Energy Consumption Regression Equation

System Efficiency	A	B	C	D
Single Stage (Below 13 SEER)	50.91	22.59	0.00	114.21
Single Stage (13-15 SEER)	47.43	29.57	12.30	45.60
Dual Stage (All over 15 SEER)	147.38	0.00	13.98	52.42

3.1.4 Demand Savings Factor (DSF)

The DSF represents the percent savings over baseline cooling demand attributable to the efficiency measure. DSF calculations are based on a combination of calibrated engineering models, field metering in APS service territory and measure-specific literature reviews.

3.1.5 Energy Savings Factor (ESF)

The ESF represents the percent savings over baseline energy consumption attributable to the efficiency measure. ESF values are based on a combination of calibrated engineering models, field metering in APS service territory and measure-specific literature reviews.

3.1.6 Coincidence Factor (CF)

The coincidence factor represents the percent of HVAC equipment in use during APS's peak period. The baseline demand estimates are specific to the coincident period and thus the coincidence factor is assumed to be 1.0.

3.2 Measure Characterization

3.2.1 Duct Test and Repair

3.2.1.1 Applicability

Retrofit

3.2.1.2 Applicable Programs

This measure is applicable to the APS Residential HVAC program and the APS Home Performance with Energy Star program.

3.2.1.3 Measure Description

The Duct Test and Repair measure consists of testing the ducts for leakage and repairing them as needed. The duct testing includes determining the amount of air leakage, identifying leakage locations, making sure the duct connections are securely fastened and providing results of test to the homeowner. The duct repair includes repairing ductwork, sealing duct connections with long lasting sealant, and repairing any unsealed or poorly fitting grills. The ducts are then retested after the repairs and sealing are completed to verify leakage reduction.

3.2.1.4 Baseline Equipment Definition

The baseline air conditioning system is assumed to be a SEER 11 system with unsealed ducts.

3.2.1.5 Efficient Equipment Definition

The efficient case air conditioning system is SEER 11 with sealed ducts.

3.2.1.6 Unit Basis

This measure's incentive, savings, and incremental measure cost are determined on a "per air conditioning system" basis.

3.2.1.7 Effective Useful Life

This measure has an effective useful life of 18 years, sourced from DEER 2008.

3.2.1.8 Incremental Measure Cost

The incremental cost for duct test and repair in traditional single-family homes is $907 based on an invoice review of program participants. The incremental cost for duct test and repair in manufactured homes is $375 based on contractor interviews.

3.2.1.9 Annual Energy Savings Algorithm

The following algorithm is used to estimate annual energy saving impacts for this measure. Numeric values for the variables can be found in Table 3-3.

$$\Delta kWh = Size \times kWh_{base,cooling} \times ESF$$

Where:

ΔkWh	=	Energy savings for measure (in kWh)
Size	=	Average unit size of the system
$kWh_{base,cooling}$	=	Baseline cooling energy consumption per ton
ESF	=	Energy savings factor

3.2.1.10 Coincident Peak Demand Savings Algorithm

The following algorithm is used to estimate coincident demand saving impacts for this measure. Numeric values for the variables can be found in Table 3-3.

$$\Delta kW_{coincident} = Size \times kW_{base,cooling} \times DSF \times CF$$

Where:

$\Delta kW_{coincident}$	=	Peak demand savings for this measure (in kW)
Size	=	Average unit size of the system
$kW_{base,cooling}$	=	Baseline cooling power demand per ton
DSF	=	Demand savings factor
CF	=	Coincidence factor (100% for this measure)

3.2.2 Prescriptive Duct Repair

3.2.2.1 Applicability

Retrofit

3.2.2.2 Applicable Programs

This measure is applicable to the APS Residential HVAC program.

3.2.2.3 Measure Description

The Prescriptive Duct Repair measure consists of sealing ducts at the most common leakage points. The duct sealing includes identifying leakage locations, ensuring duct connections are securely fastened, sealing duct connections with long lasting sealant, right-sizing the air return, and repairing any unsealed or poorly fitting grills.

3.2.2.4 Baseline Equipment Definition

The baseline air conditioning system is assumed to be a SEER 11 system with unsealed ducts.

3.2.2.5 Efficient Equipment Definition

The efficient case air conditioning system is assumed to be a SEER 11 system with prescriptively sealed ducts.

3.2.2.6 Unit Basis

This measure's incentive, savings, and incremental measure cost are determined on a "per air conditioning system" basis.

3.2.2.7 Effective Useful Life

This measure has an effective useful life of 18 years, sourced from DEER 2008.

3.2.2.8 Incremental Measure Cost

The incremental cost for duct test and repair in traditional single-family homes is $300 based on contractor quotes.

3.2.2.9 Annual Energy Savings Algorithm

The following algorithm is used to estimate annual energy saving impacts for this measure. Numeric values for the variables can be found in Table 3-3.

$$\Delta kWh = Size \times kWh_{base,cooling} \times ESF$$

Where:

ΔkWh	=	Energy savings for measure (in kWh)
Size	=	Average unit size of the system
$kWh_{base,cooling}$	=	Baseline cooling energy consumption per ton
ESF	=	Energy savings factor

3.2.2.10 Coincident Peak Demand Savings Algorithm

The following algorithm is used to estimate coincident demand saving impacts for this measure. Numeric values for the variables can be found in Table 3-3.

$$\Delta kW_{coincident} = Size \times kW_{base,cooling} \times ESF \times CF$$

Where:

$\Delta kW_{coincident}$	=	Peak demand savings for this measure (in kW)
Size	=	Average unit size of the system

$kW_{base,cooling}$	=	Baseline cooling power demand per ton
DSF	=	Demand savings factor
CF	=	Coincidence factor (100% for this measure)

3.2.3 Advanced Diagnostic Tune Up

3.2.3.1 Applicability

Retrofit

3.2.3.2 Applicable Programs

This measure is applicable only to the residential HVAC program.

3.2.3.3 Measure Description

The advanced diagnostic tune up measure is a refrigerant charge and airflow correction for residential air conditioners and heat pumps that are at least three years old between two and five tons.

3.2.3.4 Baseline Equipment Definition

The baseline equipment is the existing HVAC equipment, which is at least three years old and between two and five tons. Baseline equipment has varying efficiency levels.

3.2.3.5 Efficient Equipment Definition

The efficient equipment is the existing HVAC equipment with the proper refrigerant charge and airflow.

3.2.3.6 Unit Basis

This measure's incentive, savings, and incremental measure cost are determined on a "per unit" basis.

3.2.3.7 Effective Useful Life

This measure has an effective useful life of 6 years. This is a conservative assumption determined from the CA DEER 2008, which gives an effective useful life of 10 years.

3.2.3.8 Incremental Measure Cost

The incremental cost for this measure is $157 and is based on contractor interviews and estimates of time to complete the tune up and associated labor rates.

3.2.3.9 Annual Energy Savings Algorithm

The following algorithm is used to estimate annual energy saving impacts for this measure. Numeric values for the variables can be found in Table 3-3.

$$\Delta kWh = Size \times kWh_{base,cooling} \times ESF$$

Where:

ΔkWh	=	Energy savings for measure (in kWh)
Size	=	Average unit size of the system
$kWh_{base,cooling}$	=	Baseline cooling energy consumption per ton
ESF	=	Energy savings factor (10% for this measure)

3.2.3.10 Coincident Peak Demand Savings Algorithm

The following algorithm is used to estimate coincident demand saving impacts for this measure. Numeric values for the variables can be found in Table 3-3.

$$\Delta kW_{Coincident} = Size \times kW_{base,cooling} \times DSF \times CF$$

Where:

$\Delta kW_{coincident}$	=	Peak demand savings for this measure (in kW)
Size	=	Average unit size of the system
$kW_{base,cooling}$	=	Baseline cooling power demand per ton
DSF	=	Demand savings factor (13% for this measure)
CF	=	Coincidence factor (100% for this measure)

3.2.4 Equipment Replacement with Quality Installation

3.2.4.1 Applicability

Replace on Burnout

3.2.4.2 Applicable Programs

This measure is applicable to APS's residential HVAC program.

3.2.4.3 Measure Description

The equipment replacement with quality installation measure gives an incentive for customers to use a Participating Contractor to replace an air conditioner or heat pump that is at least ten years old with a new system that is installed in accordance with APS Quality Installation Standards.

3.2.4.4 Baseline Equipment Definition

The baseline equipment is a SEER 14, EER 11.1 air conditioner. This is the current standard efficiency for residential HVAC equipment.

3.2.4.5 Efficient Equipment Definition

The efficient case equipment is a 14.6 SEER, 11.9 EER air conditioner. These values are the average values of all 2012 equipment replacement participants.

3.2.4.6 Unit Basis

This measure's incentive, savings, and incremental measure cost are determined on a "per unit" basis.

3.2.4.7 Effective Useful Life

This measure has an effective useful life of 10 years.

3.2.4.8 Incremental Measure Cost

The incremental cost of quality installation comes from a contractor survey of four Phoenix area contractors completed by Navigant. The survey indicated that the cost is $110 per hour for three hours, totaling $330 per system.

3.2.4.9 Annual Energy Savings Algorithm

The following algorithm is used to estimate annual energy saving impacts for this measure. Numeric values for the variables can be found in Table 3-3.

$$\Delta kWh = Size \times kWh_{base,cooling} \times ESF$$

Where:

ΔkWh	=	Energy savings for measure (in kWh)
Size	=	Average unit size of the system
$kWh_{base,cooling}$	=	Baseline cooling energy consumption per ton
ESF	=	Energy savings factor (10% for this measure)

3.2.4.10 Coincident Peak Demand Savings Algorithm

The following algorithm is used to estimate coincident demand saving impacts for this measure. Numeric values for the variables can be found in Table 3-3.

$$\Delta kW_{coincident} = Size \times kW_{base,cooling} \times DSF \times CF$$

Where:

$\Delta kW_{coincident}$	=	Peak demand savings for this measure (in kW)
Size	=	Average unit size of the system
$kW_{base,cooling}$	=	Baseline cooling power demand per ton
DSF	=	Demand savings factor (20% for this measure)
CF	=	Coincidence factor (100% for this measure)

NAVIGANT

3.2.5 Western Cooling Control

3.2.5.1 Applicability

Retrofit

3.2.5.2 Applicable Programs

This measure is applicable to APS's residential HVAC program and the Solutions for Business programs.

3.2.5.3 Measure Description

Western cooling control is a retrofit measure added to residential HVAC equipment manufactured prior to 2006. Western cooling control improves the efficiency of air conditioners by extending the fan run time to extract the stored cooling after the compressor cycles off.

3.2.5.4 Baseline Equipment Definition

The baseline equipment is a SEER 11.4, EER 10.0 air conditioner. This is the average efficiency for installed residential HVAC equipment based on the program data from the advanced diagnostic tune-up measure.

3.2.5.5 Efficient Equipment Definition

The efficient case equipment is a SEER 11.4, EER 10.0 air conditioner, with a western cooling control device retrofit.

3.2.5.6 Unit Basis

This measure's incentive, savings, and incremental measure cost are determined on a "per unit" basis.

3.2.5.7 Effective Useful Life

This measure has an effective useful life of 8 years.

3.2.5.8 Incremental Measure Cost

The incremental cost for western cooling control comes from a contractor survey of four Phoenix area contractors completed by Navigant. The survey indicated that the labor cost is $110 per hour for 0.3 hours, totaling $33 per system. The cost for the western cooling control device is $35. The total incremental cost is $68.

3.2.5.9 Annual Energy Savings Algorithm

The following algorithm is used to estimate annual energy saving impacts for this measure. Numeric values for the variables can be found in Table 3-3.

$$\Delta kWh = S_{av} \times kWh_{base\_cooling} \times SF$$

Where:

ΔkWh	=	Energy savings for measure (in kWh)
Size	=	Average unit size of the system
$kWh_{base,cooling}$	=	Baseline cooling energy consumption per ton
ESF	=	Energy savings factor (10.5% for this measure)

3.2.5.10 Coincident Peak Demand Savings Algorithm

The following algorithm is used to estimate coincident demand saving impacts for this measure. Numeric values for the variables can be found in Table 3-3.

$$\Delta kW_{coincident} = Size \times kW_{base,cooling} \times DSF \times CF$$

Where:

$\Delta kW_{coincident}$	=	Peak demand savings for this measure (in kW)
Size	=	Average unit size of the system
$kW_{base,cooling}$	=	Baseline cooling power demand per ton
DSF	=	Demand savings factor (2.4% for this measure)
CF	=	Coincidence factor (100% for this measure)

3.3 Algorithm Input Values by Measure

Table 3-3. Summary of Common Parameters – Res HVAC

Measure	Building Type	Average Unit Size (tons)	Assumed Baseline SEER	Baseline Demand (kW/ton)	Baseline Cooling Energy (kWh/ton)	Demand Savings Factor	Energy Savings Factor
Duct Test and Repair	Single Family Home	3.8	11	3.86	5,560	23.0%	16.8%
	Manufactured Home	2.4	11	2.46	3,540	41.0%	30.1%
Prescriptive Duct Repair	Single Family Home	3.7	11	3.44	5,014	11.5%	8.4%
Advanced Diagnostic Tune Up	Single Family Home	3.7	11.5	3.41	4,888	8.0%	10.0%
Equipment Replacement with Quality Installation	Single Family Home	3.7	14	0.88	1,266	20.0%	13.0%
Western Cooling Control	Single Family Home	3.7	11.4	1.0	1,288	2.4%	10.5%
Western Cooling Control	Non-Residential[a]	5.0	14.1	0.9	1,233	2.4%	10.5%

[a]*Algorithm parameters for non-residential applications are referenced from typical values from the Solutions for Business Program.*

4. RESIDENTIAL NEW CONSTRUCTION

4.1 Baseline and Program Home Descriptions

Energy and coincident peak demand savings for the Residential New Construction program are determined from simulation modeling. This section describes the assumed baseline and program homes and defines the model inputs.

4.1.1 Non-Participant Home

The non-participant home is defined as the baseline condition used to estimate savings for the Residential New Construction program and represents a home built outside of the APS ENERGY STAR® Homes Program. The non-participant home is based on a blend of three International Energy Conservation Code (IECC)[25] vintages, simulated separately, and results weighted by program participation in each APS jurisdiction[26]. Refer to Table 4-1 for a summary of non-participant building characteristics for each code vintage.

4.1.2 ENERGY STAR® Homes V3.0

ENERGY STAR® Homes V3.0 is a participant home built and incentivized in the APS ENERGY STAR Homes Program meeting ENERGY STAR® version 3.0 standards. Builders are required to follow either a prescriptive or performance path and achieve an ENERGY STAR® certification verified by a HERS rater. By meeting the standards set forth by the EPA, a builder is eligible for rebates pending approval by the APS ENERGY STAR® Homes Program. Refer to Table 4-1 for a summary of *ENERGY STAR® Homes V3.0* building characteristics.

4.1.3 ENERGY STAR® Homes V3.0 – Tier 2

ENERGY STAR® Homes V3.0 – Tier 2 is a participant home built and incentivized in the APS ENERGY STAR® Homes Program meeting ENERGY STAR® version 3.0 standards and achieves a HERS score of 60 or lower. Refer to Table 4-1 for a summary of *ENERGY STAR® Homes V3.0 – Tier 2* building characteristics.

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[25] Internationally recognized conservation code developed by the International Code Council http://www.iccsafe.org/codes-tech-support/codes/2015-i-codes/iecc/

[26] Arizona is a Home Rule state meaning there is no statewide energy code enforced allowing each jurisdiction the ability to adopt/amend any preferred code.

Table 4-1. Building Characteristics Used to Inform Simulation Models.

Building Characteristic		Baseline			Participant Homes	
		IECC 2006	IECC 2009	IECC 2012	ESTAR Homes V3.0	ESTAR Homes V3.0 – Tier 2
Building Envelope	Ceiling R-Value	30.3	30.3	38.5	32.8	36.1
	Floor R-Value	13.3	13.3	14.3	26.0	26.0
	Wall R-Value	10.6	10.6	12.0	18.2	21.3
	Infiltration (ACH50)	9.0	7.0	5.0	5.2	3.8
Windows	U-Value	0.75	0.65	0.40	0.35	0.34
	SHGC	0.40	0.30	0.25	0.22	0.22
HVAC	Cooling Efficiency (SEER)	13.0	13.0	14.0	13.9	14.1
	Total Duct Leakage (%)	21%	18%	8%	7%	7%
	Duct Leakage - Outside (%)	18%	15%	5%	4%	3%
Rating	HERS	n/a	**n/a**	**n/a**	**67**	**57**

4.2 Measure Characterizations

4.2.1 ENERGY STAR New Homes®

This measure characterization applies to the following measures:

- ENERGY STAR Homes V3.0
- ENERGY STAR Homes V3.0 – Tier 2.

4.2.1.1 Applicability

New Construction

4.2.1.2 Applicable Programs

This measure is applicable to the Residential New Construction Program.

4.2.1.3 Measure Description

This whole house option promotes ENERGY STAR® certified new homes designed and built to standards well above most other new homes. An ENERGY STAR certified home has undergone a process of inspections, testing, and verification to meet strict requirements set by the EPA, delivering better quality, better comfort, and better durability. Features include the following:

- Improved insulation

- High-efficiency heating and cooling systems
- Energy-efficient low-E windows
- Tight construction and ducts
- Energy-efficient lighting and appliances
- Fresh air ventilation and room pressure balancing for improved indoor air quality
- Independent test and inspections

APS ENERGY STAR Homes meet or exceed stringent EPA/DOE Energy Star standards[27].

4.2.1.4 Baseline Equipment Definition

The baseline home is a newly constructed home not receiving a rebate through the APS ENERGY STAR® Homes Program which lies within APS service territory. See section 4.1for more details.

4.2.1.5 Efficient Equipment Definition

The efficient case refers to homes rebated through the APS ENERGY STAR Homes Program in either of the following categories. See section 4.1for more details.

- ENERGY STAR Homes V3.0
- ENERGY STAR Homes V3.0 – Tier 2.

4.2.1.6 Unit Basis

This measure's incentive, savings, and incremental measure cost are determined on a "per home" basis.

4.2.1.7 Effective Useful Life

This measure has an effective useful life of 20 years.

4.2.1.8 Incremental Measure Cost

The incremental cost for this measure varies depending on home size and energy efficient measures installed. Costs are based on a combination of "whole building" costs sourced from secondary literature[28] and "built-up" component costs based on HERS rater interviews. See Table 4-2 for aggregated incremental costs by program. For specific incremental costs, refer to the MAS.

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[27] Guidelines for ENERGY STAR Certified New Homes can be found at http://www.energystar.gov/index.cfm?c=bldrs_lenders_raters.nh_v3_guidelines

[28] National Energy and Cost Savings for New Single- and Multifamily Homes, U.S. Department of Energy found at: http://www.energycodes.gov/sites/default/files/documents/NationalResidentialCostEffectiveness.pdf

4.2.1.9 Annual Energy Savings Algorithm

Energy and coincident peak demand savings for the Residential New Construction measure are based on calibrated DOE-2[29] simulation models. DOE-2 is an industry-accepted software for modeling the interactive effects of the energy efficient measures installed in participant homes.
The following algorithm is used to estimate annual energy saving impacts estimated from the simulation modeling for this measure.

$$\Delta kWh = kWh_{Base} - kWh_{EE}$$

Where:

ΔkWh	=	Energy savings for measure (in kWh)
kWh_{Base}	=	Annual energy consumption of the baseline/ non-participant home
kWh_{EE}	=	Annual energy consumption of the participant home

4.2.1.10 Coincident Peak Demand Savings Algorithm

Hourly simulation outputs are used to estimate baseline and participant home coincident peak demand. The following algorithm is used to estimate impacts for coincident peak demand.

$$\Delta kW_{Coincident} = kW_{Base} - kW_{EE}$$

Where:

$\Delta kW_{coincident}$	=	Coincident peak demand savings for this measure (in kW)
kW_{Base}	=	Annual coincident peak demand of the baseline/ non-participant home
kW_{EE}	=	Annual coincident peak demand of the participant home

4.3 Algorithm Inputs Value

Algorithm inputs are derived using annual estimates from simulation models. The following values are normalized using participation counts to derive an overall program input. For more specific breakdowns, refer to the MAS.

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[29] DOE-2 is a public software program that performs advanced building energy simulations, and can be found at: http://doe2.com/

Table 4-2. Summary Consumption and Demand Values for Each Program.

Model Category	Area (ft^2)	kWh_{Base}	kWh_{EE}	kW_{Base}	kW_{EE}	Incremental Costs
ESTAR Homes V3.0	2,225	12,126	10,063	3.15	2.37	$1,455
ESTAR Homes V3.0 – Tier 2	2,756	13,612	10,259	3.71	2.29	$2,185
Total Program	**2,337**	**12,540**	**10,366**	**3.27**	**2.36**	**$1,818**

5. HOME PERFORMANCE WITH ENERGY STAR®

APS's Home Performance with ENERGY STAR® has two components. The process begins with a comprehensive assessment of the home. During the assessment, direct install measures are installed to promote energy efficient lighting, water efficiency and appliance savings. The customer is then eligible for additional envelope measures which promote energy efficiency while focusing on the building shell.

5.1 Direct Install Compact Fluorescent Lamps (CFLs)

The direct install CFLs lighting end-use measure promotes energy efficient residential lighting. CFLs offer a longer effective useful life than other similar lighting sources and use less energy to produce a comparable amount of light. Refer to section 6.1for more information on the algorithms and derivations of algorithm inputs for this measure.

5.2 Direct Install Light-Emitting Diode (LED)

The direct install LED lighting end-use measure promotes energy efficient residential lighting. LED offer a longer effective useful life than other similar lighting sources and use less energy to produce a comparable amount of light. Refer to section 6.2 for more information on the algorithms and derivations of algorithm inputs for this measure.

5.3 Direct Install Low Flow Devices

The direct install low flow devices measure promotes energy efficient hot water consumption in residences. Low flow faucet aerators and low flow showerheads reduce the flow rate that hot water is consumed and ultimately the volume of hot water consumed. Refer to section 6.3for more information on the algorithms and derivations of algorithm inputs for this measure.

5.4 Direct Install Smart Strips

The direct install smart strip measure promotes energy efficiency by minimizing the amount of time connected loads are consuming power in Off Mode or Standby Mode for a home entertainment system.

5.4.1 Algorithm Input Descriptions

5.4.1.1 Usage Characteristics of Home Entertainment Centers

All usage characteristics of home entertainment centers (i.e., Hours Application not-in-use, load on standby, load when technology is off, percentage of appliance use when television is on) used in Section 5.4.3are sourced from a study completed by Hiner and Partners.[30]

5.4.1.2 In-Service Rate (ISR)

The In-Service Rate (ISR) refers to the percentage of incentivized smart strips that are installed and operational at a given time. The ISR for the smart strips is estimated to be 90%.

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[30] All usage characteristics of home entertainment centers and home offices are from Hiner and Partners Data which was compiled in a study for San Diego Gas & Electric.

5.4.1.3 Coincidence Factor (CF)

The Coincidence Factor (CF) is the fraction of program participants' peak demand savings occurring during APS' system peak. The values in Section 5.4.3comes from the Efficiency Vermont coincidence factor for smart strip measure and in the absence of empirical evaluation data, the value was based on assumptions of the typical run pattern for televisions and computers in homes.

5.4.2 Measure Characterization

5.4.2.1 Applicability

Retrofit

5.4.2.2 Applicable Programs

This measure is applicable to the APS Home Performance with Energy Star program.

5.4.2.3 Measure Description

This measure is for load-based smart strips. The measure should only be installed in the primary entertainment center and primary home office. Based on the analysis data, these scenarios have up to six downstream plug loads each. Because the cost difference between six-plug and eight-plug smart strips is insignificant, either plug count qualifies as the measure. A larger plug count allows for some customer flexibility to install additional loads as needed.

5.4.2.4 Baseline Equipment Definition

The baseline power strip system is presumed to be always on, allowing connected loads to consume power in Off Mode and Standby Mode.

5.4.2.5 Efficient Equipment Definition

The efficient case is a Direct Install Smart Strip that is installed when the customer has a home entertainment system or home office. The Smart Strip technology links one home electronic device to a series of other electronics. When the main device is shut off, the Smart Strip will terminate power to the other linked devices. For example, if the Smart Strip is connected to the home television, once the television is turned off, the strip will terminate power to the DVD player, gaming system, and amplifier also plugged into the strip.

5.4.2.6 Unit Basis

This measure's incentive, savings, and incremental measure cost are determined on a per smart strip basis.

5.4.2.7 Effective Useful Life

This measure has an effective useful life of 4 years, sourced from BC Hydro report: Smart Strip electrical savings and usability, October 2008.

5.4.2.8 Incremental Measure Cost

The incremental cost for smart strips is $22.49 based on a review of qualifying products available in the market.

5.4.2.9 Annual Energy Savings Algorithm

The following algorithm is used to estimate annual energy saving impacts for this measure. Numeric values for the variables can be found in Table 5-1. (Power Consumption in Standby Mode (W) * % of Time not in use in Standby Mode * % of Peripherals used with PC/TV)+(Power Consumption in Off Mode (W) * % of Time not in use in Off Mode * % of Peripherals used with PC/TV)

$$\Delta kWh = \sum_{i}^{n}\Big(HrsApplication_{not\ in\ use} * \big((kWLoad_{standby} * \%Time_{standby}) + (kWLoad_{off} * \%Time_{off})\big) * \%TimeApplied * weeks/year * ISR\Big)$$

Where:

ΔkWh	=	Energy savings for measure (in kWh)
i	=	Technologies
n	=	Number of technologies attached to the smart strip
$HrsApplication_{not\ in\ use}$	=	Time/week the application (PC or TV) is not in use
$kWLoad_{standby}$	=	Energy consumption (kW) of the load in standby mode
$\%Time_{standby}$	=	Time in standby mode as a percentage of time the application is not in use
$kWLoad_{off}$	=	Energy consumption (kW) of the load in off mode
$\%Time_{off}$	=	Time in off mode as a percentage of time the application is not in use
$\%TimeApplied$	=	% of time the appliance is used simultaneously with the application (PC or TV)
$weeks/year$	=	Number of weeks per year
ISR	=	In-Service Rate

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5.4.2.10 Coincident Peak Demand Savings Algorithm

The following algorithm is used to estimate coincident demand saving impacts for this measure. Numeric values for the variables can be found in Table 5-1.

$$\Delta kW_{coincident} = \sum_{i}^{n}\left(\left(\left(kWLoad_{standby} \cdot \%Time_{standby}\right) + \left(kWLoad_{off} \cdot \%Time_{off}\right)\right) \cdot \%TimeApplied \cdot CF\right)$$

Where:

$\Delta kW_{coincident}$	=	Peak demand savings for this measure (in kW)
i	=	Technologies
n	=	Number of technologies attached to the smart strip
$kWLoad_{standby}$	=	Energy consumption (kW) of the load in standby mode
$\%Time_{standby}$	=	Time in standby mode as a percentage of time the application is not in use
$kWLoad_{off}$	=	Energy consumption (kW) of the load in off mode
$\%Time_{off}$	=	Time in off mode as a percentage of time the application is not in use
$\%TimeApplied$	=	% of time the appliance is used simultaneously with the application (PC or TV)
CF	=	Coincidence factor (80% for this measure)

5.4.3 Algorithm Input Values

Table 5-1 shows specific analysis values that are relevant for 2013. All values are subject to change as program specific data is collected and used in the analysis.

Navigant aligns the values listed here with implementation tracking data to calculate savings for all smart strips rebated through the program. These values serve as the basis for APS tracked savings.

Table 5-1. Smart Strip Measure Analysis Values

Technology	HrsApplication not in use	kW Load standby	%Time standby	kW Load off	%Time off	%Time Applied	ISR	CF
DVD player	130.5	0.01177	5%	0.00157	95%	93%	90%	80%
VCR	130.5	0.01285	11%	0.00502	89%	98%	90%	80%
Stereo	130.5	0.02738	7%	0.00229	93%	51%	90%	80%
Speakers, subwoofers	130.5	0.01107	21%	0.01107	79%	86%	90%	80%
Video game consoles	130.5	0.0021	12%	0.00036	88%	98%	90%	80%
Computer only used for video/music entertainment	130.5	0.04697	33%	0.00317	67%	67%	90%	80%

5.5 Behavioral Savings

The Behavioral Savings measure, a component of the Home Performance with ENERGY STAR® program, provides participating Residential customers with behavioral savings recommendations containing information designed to motivate them to change their energy usage behavior to save energy. Program savings are determined from an engineering analysis of self-reported compliance with the behavioral suggestions.

5.5.1 Program Definitions and Algorithm Input Descriptions

The following sections define key terms used in the discussion and characterization of savings and costs for the Behavioral Savings measure.

5.5.1.1 Behavioral Savings Recommendations

Behavioral savings recommendations motivate program participants to save energy through energy conservation behaviors. Users who complete the online home energy audit receive three customized behavioral savings recommendations listed in Table 5-2.

5.5.1.2 Program Participants

This group consists of confirmed APS customers who completed the online home energy audit offered by APS in 2015 and were provided with three behavioral savings recommendations. These customers' APS accounts are verified through creation of a username and password on the APS website that is directly tied to their APS account number.

Residential Behavioral Program (see Section 8) participants receiving behavioral savings recommendations are excluded from the savings analysis to avoid double counting of savings.

5.5.1.3 Presentation Frequency

The presentation frequency is the percent of time that a particular behavioral recommendation is presented as one of the three recommendations.

5.5.1.4 Follow Through Rate

The follow through rate is the percent of time that each participant actually follows the behavioral recommendation.

5.5.2 Measure Characterization

5.5.2.1 Applicability

Retrofit

5.5.2.2 Applicable Programs

This measure is only applicable to the Home Performance with ENERGY STAR® program.

5.5.2.3 Measure Description

The Behavioral Savings measure provides participating Residential customers with behavioral savings recommendations containing information designed to motivate them to change their energy usage behavior to save energy.

To drive conservation behavior, this measure uses results from the online home energy audit completed by participants to personalize the behavioral savings recommendation based on participant's self-reported home characteristics. Targeted, personalized, and no cost messages about how to reduce energy use is the basis of the savings for this measure.

5.5.2.4 Baseline Definition

The baseline in this case is the program participants' energy consumption without performing the behavioral savings recommendations.

5.5.2.5 Efficient Definition

The efficient case is the program participants' energy consumption after performing the behavioral savings recommendations.

5.5.2.6 Unit Basis

This measure's savings, and incremental measure cost are determined on a "per participant" basis.

5.5.2.7 Effective Useful Life

This measure has an effective useful life of 1 year based on the assumption that behavioral modifications do not persist beyond 1 year.

5.5.2.8 Incremental Measure Cost

There is no incremental measure cost associated with this program because program participants incur no cost as a result of implementing behavioral savings recommendations.

5.5.2.9 Annual Energy Savings Algorithm

Total savings for this measure are calculated as the sum of the savings for each behavioral recommendation, adjusted for the presentation frequency and follow through rate for each recommendation. Savings for each behavioral savings recommendation, as a percentage of annual consumption for a participant home, are based on engineering analysis and a review of secondary literature.

The following algorithms present the derivation of annual energy saving impacts from this measure:

$$\Delta kWh = \sum_{B1\_Bx} \Delta kWh_{B1\_Bx} \times \%PF_{B1\_Bx} \times \%FTR_{B1\_Bx}$$

$$\Delta kWh_{B1\_Bx} = \%\Delta kWh_{B1\_Bx} \times kWh_{avg\ home}$$

Where:

ΔkWh	= Annual energy savings for this measure (in kWh)
ΔkWh_{B1_Bx}	= Total energy savings (in kWh) for implementing a single behavioral recommendation
$\%PF_{B1\_Bx}$	= Presentation frequency of each particular behavioral recommendation as a % of times each behavior is shown to the total group of program
$\%FTR_{B1\_Bx}$	= The percent of time that each participant implements the behavioral recommendation.
$\%\Delta kWh_{B1\_Bx}$	= Percent savings from each behavioral recommendation as a percentage (%) of total annual home consumption.
$kWh_{avg\ home}$	= Average annual consumption of each participant home (in kWh).

5.5.2.10 Coincident Peak Demand Savings Algorithm

Hourly simulation outputs from Residential New Construction program energy simulation models are used to estimate baseline home coincident peak demand. The following algorithm is used to estimate impacts for coincident peak demand.

$$\Delta kW_{Coincident} = \Delta kWh * \%\Delta kW_{peak}$$

$\Delta kW_{coincident}$	=	Coincident peak demand savings for this measure (in kW)
ΔkWh	=	Annual energy savings for this measure (in kWh)
$\%\Delta kW_{peak}$	=	The average portion of the whole house load that coincides with APS' peak period

5.5.3 Algorithm Input Values

Table 5-2 and Table 5-4 display the inputs to the algorithm above to estimate "per participant" savings for participants. The follow through rate values were derived from secondary sources and engineering judgment as well as feedback from a small number of online audit participants who responded about their level of use in a post survey questionnaire. Data from the online audit directly shaped the values used for the presentation frequency where a handful of measures were presented quite frequently and some not at all. Note that in each online survey, three behavioral changes were presented to the customer resulting in a total presentation frequency of 300%.

Table 5-2. Detailed Algorithm Input Values for Behavioral Savings by Behavior

Behavior	Presentation Frequency (Survey Responders)	Follow Through Rate (Survey Responders)	Presentation Frequency (Survey Non-Responders)	Follow Through Rate (Survey Non-Responders)
Reduce pool pump run-time	15%	10%	23%	5%
Turn up your AC	58%	10%	59%	10%
Program your thermostat with a setback	0%	10%	0%	10%
Dry clothes outside	70%	5%	79%	5%
Actively deflect the sun's heat	100%	10%	100%	5%
Replace air filter regularly	8%	10%	4%	10%
Turn down your heat	0%	10%	0%	10%
Consider AC zoning and/or close doors to unoccupied rooms	0%	10%	0%	10%
Use computer power-saving modes	0%	10%	0%	10%
Deactivate water heater if away	0%	5%	0%	5%
Run only full loads of laundry	0%	10%	0%	10%
Take shorter showers	49%	10%	35%	5%
Use natural ventilation to cool your home	0%	10%	0%	10%
Set your TV and monitors to energy saver mode	0%	10%	0%	10%
Turn off your computer at night or while away	0%	5%	0%	5%
Cook meals outside	0%	10%	0%	10%

Unplug your electronics/turn off powerstrips	0%	5%	0%	5%
Increase refrigerator temperature	0%	5%	0%	5%
Light only needed areas, use task lighting	0%	5%	0%	5%
Wash dishes with a full dishwasher	0%	10%	0%	10%
Clear items from obstructing vents	0%	5%	0%	5%

Presentation frequency and follow through rates also varied between those online audit participants that responded to the survey and those that did not respond to the survey. Presentation frequency varied simply based on the raw data from which measures were presented to each type of responder. Follow through rate non-responders was kept the same as the pre-audit projection—these participants provided no feedback, so there was not a method for adjusting their relative participation after being presented with the online audit. The participant follow through rates were adjusted slightly based on which of the presented measures the participants indicated actually implementing.

As shown in Table 5-3 there were far fewer users who did respond to the survey than those who did not respond to the survey. As expected based on the different presentation frequencies and follow through rates, the savings per home were higher for those participants that actively engaged in the survey. Note also that participant counts have been scaled down by 12.5% to make sure that the survey does not account for overlap with OPOWER HER customers.

Table 5-3: Survey responder and non-responder counts

User Type (Excluding OPOWER Customers)	User Count	Savings per home (kWh)
Users that actively engaged by responding to emails	195	157.4
Users that received behavioral tips	5893	109.6
Total annual verified savings	6088	111.1

The online audit savings are also dependent on the size of the home being evaluated. Larger homes with larger base usage also have higher potential for savings. Also clear from these data is that survey responder homes can be attributed greater savings than non-responders based on the fact that those responders indicated higher participation with the measures they were implementing.

Table 5-4: Algorithm Input Value for Average Annual Home Consumption

Home Size	Average Home (kWh)	Responder Savings (kWh)	Non-responder Savings (kWh)	Weighted savings per home (kWh)
Small	11,314	114	79	80.5
Medium	15,446	156	108	109.9
Large	20,066	202	141	142.8

5.6 Envelope Measures

The APS Home Performance with ENERGY STAR® program encourages envelope upgrades that focus on the building shell for added comfort and energy savings. In order to capture the interactive effects associated with the envelope upgrades, energy and coincident peak demand savings for the APS Home Performance with ENERGY STAR® program are estimated from simulation models. This section describes the various measures offered in the program dealing with the building envelope.

5.6.1 Evaluation Methodology

For envelope measures known to generate savings across multiple end-uses, savings are estimated using a DOE-2[31] based simulation model calibrated to the overall population of participants receiving an audit. Modeling inputs are derived using the program tracking database which are divided into categories based on HVAC type and number of stories. Table 5-5 provides a detailed list of building characteristics used to populate the calibrated DOE-2 models.

[31] DOE-2 is a public software program that performs advanced building energy simulations, and can be found at: http://doe2.com/

Table 5-5. Building Characteristics used for Calibrating Simulation Models.

Building Characteristic		Model Categories				Weighted Average
		Heat Pump (1-Story)	Heat Pump (2-Story)	Gas /AC (1-Story)	Gas/AC (2-Story)	
General	Building Area (ft^2)	2,011	2,833	2,164	3,036	**2,245**
	Volume (ft^3)	18,382	27,607	20,968	29,920	**21,396**
Building Envelope	Ceiling R-Value	23.7	23.1	26.7	26.3	**25.3**
	Floor R-Value	12.5	3.5	11.9	10.8	**11.4**
	Wall R-Value	10.4	11.1	10.4	12.0	**10.6**
	Infiltration (ACH50)	7.2	8.0	7.2	8.0	**7.2**
Windows	U-Value	0.88	0.84	0.81	0.73	**0.83**
	SHGC	0.68	0.67	0.66	0.64	**0.67**
	Window/Wall Ratio	0.11	0.14	0.12	0.16	**0.12**
HVAC	Cooling Efficiency (SEER)	10	10	10	10	**10**
	Total Duct Leakage (%)	9%	9%	9%	9%	**9%**
	Duct Leakage to the Outside (%)	11%	11%	11%	11%	**11%**

The program tracking database is then leveraged to establish pre and post measure conditions for each participant receiving an upgrade. Energy and peak coincident demand savings are estimated using the calibrated models which are adjusted to simulate the pre and post conditions. Refer to Table 5-6 for modeling inputs.

5.6.2 Measure Descriptions

This section details the various measure rebates offered for building envelope upgrades through the Home Performance with ENERGY STAR® program.

5.6.2.1 Energy Audit

The Home Performance with ENERGY STAR® offers a comprehensive whole house check-up to help improve the safety, durability, comfort, and energy efficiency of a home. The energy audit must be performed by a contractor certified by the Building Performance Institute (BPI). The audit includes inspection of the A/C system, ductwork, insulation, and building envelope and requires a blower door test to measure infiltration and a measurement of duct leakage.

5.6.2.2 Attic Insulation

Attic insulation involves repairing and/or adding insulation to existing attics. Insulation must be installed in the right location and without gaps, voids, or compressions. Homes must be properly air sealed prior to increasing attic insulation to achieve maximum performance. Insulation values are based on the measure of a materials thermal resistance or R-value. Refer to Table 5-6 for normalized pre and post conditions.

5.6.2.3 Air Sealing and Attic Insulation

This measure includes installation of a combination of air sealing and attic insulation for a single participant home. Air sealing is performed prior to attic insulation for maximum performance. Air sealing involves addressing the air infiltration points in a home. There are different levels of air sealing techniques such as capping chases, sealing top plate penetrations, sealing can lights, or caulking around doors and windows. Infiltration rates are based on Air Changes per Hour (ACH) and are converted from N-factors sourced by the Lawrence Berkeley Laboratory (LBL)[32]. Refer to Table 5-6 for normalized pre and post conditions.

Table 5-6. Pre and Post Conditions for Envelope Measures

Measure Category	Installed Area (ft^2)	Pre	Post
Attic Insulation (R-value)	1,562	14.9	41.7
Air Sealing and Attic Insulation (ACH/R-value)	1,763	19.4 / 11.6	12 / 41.5

5.6.3 Measure Characterizations

The Envelope Measures incentivized through the Home Performance with ENERGY STAR program offer similar reductions in energy and are thus evaluated with a consistent approach. The following characterization applies to the measures listed in section 5.6.2.

5.6.3.1 Applicability

Retrofit

5.6.3.2 Applicable Programs

This measure is applicable to the Home Performance with ENERGY STAR® program.

[32] 284 Appendices A-11 Building Tightness Limits
http://www.waptac.org/data/files/Website_docs/Technical_Tools/Building%20Tightness%20Limits.pdf

5.6.3.3 Measure Description

This whole house approach promotes Home Performance with ENERGY STAR®, which offers ways to improve a home's comfort, durability, indoor air quality, and safety while lowering utility bills. Customers who sign up for a comprehensive assessment gain access to special rebates for increasing the energy efficiency of their home. Home energy upgrades include:

- Sealing ductwork
- Sealing air leaks
- Repairing and/or adding insulation

A combination of any of these measures will help maximize a home's efficiency.

5.6.3.4 Baseline Equipment Definition

The baseline represents the pre-condition of a home prior to installing any envelope measures. Modeling inputs are derived using program tracking data available for each participant receiving an audit. Refer to Table 5-5 for building characteristics used to populate the simulation models and Table 5-6 for pre measure installation conditions.

5.6.3.5 Efficient Equipment Definition

The efficient case refers to the post-condition of a home after installing one or a combination of the envelope measures offered through the Home Performance with ENEGY STAR® program. Modeling inputs are derived using program tracking data that represent the post-condition or the result of installing an envelope measure. Refer to Table 5-5 for building characteristics used to populate the simulation models and Table 5-6 for post measure installation conditions.

5.6.3.6 Unit Basis

This measure's incentive, savings, and incremental measure cost are determined on a "per home" basis.

5.6.3.7 Effective Useful Life

The envelope measures have an effective useful life as detailed in Table 5-7. Effective useful lives are based on a GDS Associates, Inc. report[33] and internal evaluation by Navigant.

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[33] Measure Life Report, prepared by GDS Associates, Inc. March 14, 2007 http://www.env.state.ma.us/dpu/docs/electric/08-46/82908nsteera6s9.pdf

Table 5-7. Envelope Measures Effective Useful Life

Measure	EUL
Air Sealing	15
Attic Insulation	25
Air Sealing and Attic Insulation*	22

*Weighted average based on PY2012 participation.

5.6.3.8 Incremental Measure Cost

The incremental cost for the envelope measures vary depending on installed quantities. Costs are based on in-depth market actor interviews and review of contractor invoices completed in 2012 as a part of the MER process conducted by Navigant. Refer to Table 5-8 for normalized incremental costs by measure. For specific incremental costs, refer to the MAS.

5.6.3.9 Annual Energy Savings Algorithm

Energy and coincident peak demand savings for envelope measures are based on calibrated DOE-2 simulation models. DOE-2 is an industry accepted software for modeling the interactive effects of the energy efficient measures installed in participant homes.

The following algorithm is used to estimate annual energy saving impacts estimated from the simulation modeling for this measure.

$$\Delta kWh = kWh_{Base} - kWh_{EE}$$

Where:

ΔkWh	=	Energy savings for measure (in kWh)
kWh_{Base}	=	Annual energy consumption of the baseline/ pre-condition
kWh_{EE}	=	Annual energy consumption of the efficient/ post-condition

5.6.3.10 Coincident Peak Demand Savings Algorithm

Hourly simulation outputs are used to estimate baseline and participant home coincident peak demand. The following algorithm is used to estimate impacts for coincident peak demand.

$$\Delta kW_{coincident} = kW_{Base} - kW_{EE}$$

Where:

$\Delta kW_{coincident}$	=	Coincident peak demand savings for this measure (in kW)
kW_{Base}	=	Annual coincident peak demand of the baseline/ pre-condition

kW_{EE} = Annual coincident peak demand of the efficient/ post-condition

5.6.4 Algorithm Input Values

Algorithm inputs are derived using annual estimates from simulation models. The following values are normalized using participation counts to derive an overall program estimate. For more specific breakdowns based on square footage, HVAC type and number of stories, refer to the MAS.

Table 5-8. Summary Consumption and Demand Values for Each Program.

Measure Category	kWh_{Base}	kWh_{EE}	kW_{Base}	kW_{EE}	Incremental Costs
Attic Insulation	14,673	13,603	4.43	3.86	$1,147
Air Sealing and Attic Insulation	11,577	10,391	4.11	3.44	$1,487
Envelope Measures	**14,532**	**13,457**	**4.41**	**3.84**	**$1,162**

5.7 Duct Sealing

Duct sealing involves making sure ducts are straight, properly connected, sealed, and insulated in the required locations. This process greatly improves the comfort and energy efficiency of a home. Savings and costs for duct sealing are consistent with those described in section 3.2.1.

6. MULTIFAMILY ENERGY EFFICIENCY PROGRAM

APS's Multifamily Energy Efficiency Program has two components. Its Builder Option Packages promote energy efficient multifamily building construction, and the direct install program promotes energy efficient lighting, faucet aerator and showerhead retrofits.

6.1 Direct Install Compact Fluorescent Lamps (CFLs)

6.1.1 Algorithm Input Descriptions

6.1.1.1 Hours of Operation (OpHrs)

Hours-of-operation is the average number of hours annually that a participant CFL is in operation. The value in Section 6.1.3 is derived from a 2014 field metering study and general population survey. The metering study resulted in average operating hours by space type. The general population survey resulted in the general distribution of participant CFLs across space types. The final operating hours value is the average of the space type specific hours weighted by the distribution of CFLs across those space types.

See Section 6.1.3 for specific values.

6.1.1.2 Coincidence Factor (CF)

The Coincidence Factor (CF) is the fraction of program participants' peak demand savings occurring during APS' system peak. The value in Section 6.1.3comes from a 2014 field metering study and general population survey, as well as an analysis of APS' system load.

See Section 6.1.3 for specific values.

6.1.1.3 In-Service Rate (ISR)

The In-Service Rate (ISR) refers to the percentage of incentivized bulbs that are installed and operational at a given time. The ISR for the Multifamily Energy Efficiency Program is estimated to be 100% as the program is a direct install program.

See Section 6.1.3 for specific values.

6.1.1.4 Leakage Rate (LR)

The Leakage Rate (LR) refers to the percent of bulbs that are purchased within the APS service territory, but installed outside of the territory. The leakage rate for the Multifamily Energy Efficiency Program is estimated to be 0% as the program is a direct install program.

See Section 6.1.3 for specific values.

6.1.1.5 Demand Interaction Factor (DIF)

The Demand Interaction Factor (DIF) accounts for interactive effects between lighting demand and HVAC demand so that the estimated CFL demand savings are the savings at the light source in addition to any electrical savings at the cooling system and less any increase in electrical demand at the heating system. Residential simulation modeling was used to estimate the DIF.

See Section 6.1.3 for specific values.

6.1.1.6 Energy Interaction Factor (EIF)

The Energy Interaction Factor (EIF) accounts for interactive effects between lighting energy consumption and HVAC energy consumption so that the estimated CFL energy savings are the savings at the light source in addition to any electrical savings at the cooling system and less any increase in electrical energy consumption at the heating system. Residential simulation modeling was used to estimate the EIF.

See Section 6.1.3 for specific values.

6.1.2 Measure Characterization

6.1.2.1 Applicability

Retrofit

6.1.2.2 Applicable Programs

This measure is applicable to the Multifamily Energy Efficiency Program and Home Performance with ENERGY STAR® Program.

6.1.2.3 Measure Description

This lighting end-use measure promotes energy efficient residential lighting. CFLs offer a longer effective useful life than other similar lighting sources and use less energy to produce a comparable amount of light.

6.1.2.4 Baseline Equipment Definition

The baseline lighting source is an incandescent or halogen bulb, where the baseline wattage is specific to the efficient lamp type.

Baseline estimates reflect federal efficacy standards (Energy Independence and Security Act of 2007 and DOE's 2009 rulemaking) and the market availability of existing incandescent bulbs not meeting these standards.

The base wattages corresponding to specific CFL lamp types are provided in Section 6.1.3.

6.1.2.5 Efficient Equipment Definition

The efficient case refers to Energy Star® certified compact fluorescent lamps installed through the program.

The efficient wattages corresponding to specific CFL lamp types are provided in Section 6.1.3.

6.1.2.6 Unit Basis

This measure's incentive, savings, and incremental measure cost are determined on a "per lamp" basis.

6.1.2.7 Effective Useful Life

This measure has an effective useful life of 7 years based on manufacturing specifications, an estimate of hours of use per day, engineering analysis, and secondary literature[34].

6.1.2.8 Incremental Measure Cost

The incremental cost varies with lamp wattage and is the full cost of the lamp. The costs come directly from implementer invoices.

Specific incremental costs can be found in Section 6.1.3.

6.1.2.9 Energy Savings Algorithm

$$\Delta kWh = \frac{(W_{base} - W_{ee})}{1000} \times OpHrs \times ISR \times (1 - LR) \times (1 + EIF)$$

Where:

ΔkWh	=	Energy savings for this measure (in kWh)
W_{base}	=	Baseline Fixture Wattage
W_{ee}	=	Efficient Fixture Wattage
OpHrs	=	Hours of Operation
ISR	=	In-Service Rate
LR	=	Leakage Rate
EIF	=	Energy Interaction Factor

6.1.2.10 Coincident Peak Demand Savings Algorithm

$$\Delta kW_{Coincident} = \frac{(W_{base} - W_{ee})}{1000} \times CF \times ISR \times (1 - LR) \times (1 + DIF)$$

[34] Jump et al. *Welcome to the Dark Side: The Effect of Switching on CFL Measure Life.* 2008 ACEEE Summer Study on Energy Efficiency in Buildings

Where:

$\Delta kW_{coincident}$	=	Coincident peak demand savings for this measure (in kW)
W_{base}	=	Baseline Fixture Wattage
W_{ee}	=	Efficient Fixture Wattage
CF	=	Coincidence Factor
ISR	=	In-Service Rate
LR	=	Leakage Rate
DIF	=	Demand Interaction Factor

6.1.3 Algorithm Input Values

Table 6-1 shows specific analysis values that are relevant for 2016. Baseline wattages and costs change year to year due to federal standards, federal mandates, and the market. Other values are also subject to change as more recent data is collected.

Navigant aligns the values listed here with implementation tracking data to calculate weighted average savings for all CFLs rebated through the program. These weighted averages serve as the basis for APS tracked savings.

Table 6-1. Compact Fluorescent Lamps (CFLs) Analysis Values

Model Category	Base Watts	Efficient Watts	Hours of Operation	Coincidence Factor	In-Service Rate	Leakage Rate	Demand Interaction Factor	Energy Interaction Factor	Incremental Costs (per lamp)
9 w	40	9	807	0.078	100%	0%	0.303	0.102	$3.24
13 w	60	13	807	0.078	100%	0%	0.303	0.102	$1.92
18 w	60	18	807	0.078	100%	0%	0.303	0.102	$1.97
23 w	60	23	807	0.078	100%	0%	0.303	0.102	$2.14

6.2 Direct Install Light-Emitting Diode (LED)

6.2.1 Algorithm Input Descriptions

6.2.1.1 Hours of Operation (OpHrs)

Hours-of-operation is the average number of hours annually that a participant LED is in operation. The values in Section 6.2.3 is derived from a 2014 field metering study and general population survey of CFLs. The metering study resulted in average operating hours by space type. The general population survey resulted in the general distribution of participant CFLs across space types. The final operating-hours value is the average of the space type specific hours weighted by the distribution of CFLs across those space types. It is assumed that LED operating hours are similar to CFLs.

See Section 6.2.3 for specific values.

6.2.1.2 Coincidence Factor (CF)

The Coincidence Factor (CF) is the fraction of program participants' peak demand savings occurring during APS' system peak. The value in Section 6.1.3 comes from a 2009 field metering study and general population survey, as well as an analysis of APS' system load.

See Section 6.2.3 for specific values.

6.2.1.3 In-Service Rate (ISR)

The In-Service Rate (ISR) refers to the percentage of incentivized bulbs that are installed and operational at a given time. The ISR for the Multifamily Energy Efficiency Program is estimated to be 100% as the program is a direct install program.

See Section 6.2.3 for specific values.

6.2.1.4 Leakage Rate (LR)

The Leakage Rate (LR) refers to the percent of bulbs that are purchased within the APS service territory, but installed outside of the territory. The leakage rate for the Multifamily Energy Efficiency Program is estimated to be 0% as the program is a direct install program.

See Section 6.2.3 for specific values.

6.2.1.5 Demand Interaction Factor (DIF)

The Demand Interaction Factor (DIF) accounts for interactive effects between lighting demand and HVAC demand so that the estimated LED demand savings are the savings at the light source in addition to any electrical savings at the cooling system and less any increase in electrical demand at the heating system. Residential simulation modeling was used to estimate the DIF.

See Section 6.2.3 for specific values.

6.2.1.6 Energy Interaction Factor (EIF)

The Energy Interaction Factor (EIF) accounts for interactive effects between lighting energy consumption and HVAC energy consumption so that the estimated LED energy savings are the savings at the light source in addition to any electrical savings at the cooling system and less any increase in electrical energy consumption at the heating system. Residential simulation modeling was used to estimate the EIF.

See Section 6.2.3 for specific values.

6.2.2 Measure Characterization

6.2.2.1 Applicability

Retrofit

6.2.2.2 Applicable Programs

This measure is applicable to the Multifamily Energy Efficiency Program and Home Performance with ENERGY STAR® Program.

6.2.2.3 Measure Description

This lighting end-use measure promotes energy efficient residential lighting. LEDs offer a longer effective useful life than other similar lighting sources and use less energy to produce a comparable amount of light.

6.2.2.4 Baseline Equipment Definition

The baseline lighting source is the replaced bulb, generally incandescent lighting.

The base wattages corresponding to specific LED lamp types are provided in Section 6.1.3.

6.2.2.5 Efficient Equipment Definition

The efficient case refers to light emitting diodes installed through the program.

The efficient wattages corresponding to specific LED lamp types are provided in Section 6.2.3.

6.2.2.6 Unit Basis

This measure's incentive, savings, and incremental measure cost are determined on a "per lamp" basis.

6.2.2.7 Effective Useful Life

LED measure life is based on the recommendation of using ENERGY STAR's minimum of 15,000 hours ≈ 17 years based on field research in APS territory of 876 hrs/year/bulb. The ISR is 100% for LEDs.

6.2.2.8 Incremental Measure Cost

The incremental cost varies with lamp wattage and is the full cost of the lamp net avoided future incandescent bulb purchases. The effective useful life is roughly 10 times that of an incandescent bulb. The costs come from MSRP values, in-store data and online research.

Specific incremental costs can be found in Section 6.2.3

6.2.2.9 Energy Savings Algorithm

$$\Delta kWh = \frac{(W_{base} - W_{ee})}{1000} \times OpHrs \times ISR \times (1 - LR) \times (1 + EIF)$$

Where:

ΔkWh	=	Energy savings for this measure (in kWh)
W_{base}	=	Baseline Fixture Wattage
W_{ee}	=	Efficient Fixture Wattage
OpHrs	=	Hours of Operation
ISR	=	In-Service Rate
LR	=	Leakage Rate
EIF	=	Energy Interaction Factor

6.2.2.10 Coincident Peak Demand Savings Algorithm

$$\Delta kW_{Coincident} = \frac{(W_{base} - W_{ee})}{1000} \times CF \times ISR \times (1 - LR) \times (1 + DIF)$$

Where:

$\Delta kW_{coincident}$	=	Coincident peak demand savings for this measure (in kW)
W_{base}	=	Baseline Fixture Wattage
W_{ee}	=	Efficient Fixture Wattage
CF	=	Coincidence Factor
ISR	=	In-Service Rate
LR	=	Leakage Rate
DIF	=	Demand Interaction Factor

6.2.3 Algorithm Input Values

Table 6-2 shows specific analysis values that are relevant for 2016. Baseline wattages and costs change year to year due to federal standards, federal mandates, and the market. Other values are also subject to change as more recent data is collected.

Navigant aligns the values listed here with implementation tracking data to calculate weighted average savings for all LED rebated through the program. These weighted averages serve as the basis for APS tracked savings.

Table 6-2. Light Emitting Diodes (LEDs) Analysis Values

Equivalent Bulb	Baseline Wattage	Efficient Wattage	Hours of Operation	Coincidence Factor	In-Service Rate	Leakage Rate	Demand Interaction Factor	Energy Interaction Factor	Incremental Costs (per lamp)
40 Watt	40	6.6	876	0.06	100%	0%	0.303	0.102	$5.04
60 Watt	60	10.25	876	0.06	100%	0%	0.303	0.102	$7.01
75 Watt	75	14	876	0.06	100%	0%	0.303	0.102	$11.02

6.3 Direct Install Low Flow Devices

6.3.1 Algorithm Input Descriptions

6.3.1.1 Occupants per Household

The amount of hot water saved from low flow devices varies by their use. Residences with more occupants will use their faucet aerators and showerheads with greater frequency, and as a result will have greater savings from low flow devices.

The number of occupants per household is consistent with data collected through the Home Performance with Energy Star® program.

Specific values can be found in Section 6.3.3.

6.3.1.2 Gallons per Day per Person

Gallons-per-day-per-person refers to the amount of hot water consumed per day by a single resident before the installation of low flow devices. The volume of water consumed varies by measure type (e.g. kitchen faucet aerator, bathroom faucet aerator, and showerhead).

This value comes from Building America House Simulation Protocols[35]. The protocol suggests modeling a three-bedroom, single-family home using 28 gallons of hot water consumption per day for showerheads and 25 gallons of hot water consumption per day for faucets. These values are normalized by bedroom as a proxy for the number of residents, and the faucet values are disaggregated for kitchen sinks (65% weighting) and bathroom sinks (35% weighting)[36].

The specific values are provided in Section 6.3.3.

[35] Building America House Simulation Protocols, NREL, October 2010 can be found at http://www.nrel.gov/docs/fy11osti/49246.pdf.
[36] Faucet hot water consumption is disaggregated into kitchens and bathrooms based on a suggested 2:1 weighting from a University of Minnesota document on best water management practices (http://www.extension.umn.edu/distribution/naturalresources/components/DD6946r.html).

6.3.1.3 Mains Water Temperatures (TMains)

The temperature at which water is supplied to a home is defined as the water mains temperature (TMains). Estimates for Phoenix, AZ come from Building America House Simulation Protocols[37].

The specific value is given in Section 6.3.3.

6.3.1.4 Hot Water Consumption Temperature (TUsed)

Hot water consumption temperature (TUsed) is the temperature at which hot water is used by residents. The estimates for the Multifamily Energy Efficiency Program and Home Performance with ENERGY STAR® Program come from an average of three studies[38,39,40].

See specific values in Section 6.3.3.

6.3.1.5 In-Service Rate (ISR)

The In-Service Rate (ISR) refers to the percent of incentivized low flow devices that are installed and operational at a given time. The ISR values for the different low flow devices are determined from a participant survey conducted in 2011.

See specific values in Section 6.3.3.

6.3.1.6 Conversion factor

A conversion factor of 0.89 is used in the low flow devices energy and demand savings algorithms. This value is the product of water's specific heat, water's specific weight, and the number of days per year.

6.3.1.7 Water Heater Efficiency

Low flow devices reduce the energy *load* on hot water heaters, where load refers to the energy required for a given service excluding efficiency losses. Including these efficiency losses increases the energy savings as only some percent of energy delivered to the heater ultimately transfers to the energy load.

The estimate for the Multifamily Energy Efficiency Program and Home Performance with ENERGY STAR® Program comes from the American Council for an Energy Efficient Economy[41].

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[37] Building America House Simulation Protocols, NREL, October 2010 can be found at http://www.nrel.gov/docs/fy11osti/49246.pdf.
[38] Building America House Simulation Protocols, NREL, October 2010 can be found at http://www.nrel.gov/docs/fy11osti/49246.pdf.
[39] Skeel, T. and Hill, S. Evaluation of Savings from Seattle's "Home Water Saver" Apartment/Condominium Program, 1994.
[40] A Massachusetts Low Income Evaluation of low flow devices can be found at http://www.ma-eeac.org/Docs/8.1_EMV%20Page/2012/2012%20Residential%20Studies/MA%20RR&LI%20-%202011%20Low%20Income%20Single%20Family%20Program%20Impact%20Evaluation%20FINAL_26JUNE2012.pdf.
[41] The American Council for an Energy Efficient Economy's estimate for a typical electric heater energy factor can be found at http://www.aceee.org/consumer/water-heating.

See specific values in Section 6.3.3.

6.3.1.8 Minutes Avoided (Mins avoided)

The minutes avoided (Mins Avoided) refers to the number of minutes saved from a ShowerStart™ type device. This device turns off shower flow once the water heats to ~95 F, allowing the resident to resume flow at his/her leisure, saving unused, free flowing hot water during shower preparation.

The estimate of time saved from this device comes from ShowerStart LLC www.showerstart.com.

See specific values in Section 6.3.3.

6.3.1.9 Number per Unit (No. per unit)

The number-per-unit refers to the number of low flow devices installed in a given dwelling unit/household. If a unit's hot water consumption is fixed based on the number of occupants, every additional aerator or showerhead in the unit would result in less use per device, and ultimately less savings per low flow retrofit.

The Multifamily Energy Efficiency Program estimate is based on engineering judgment, and is consistent with program data for the Home Performance with Energy Star® Program.

See specific values in Section 6.3.3.

6.3.1.10 Peak Demand Load Fraction

The peak demand load fraction is the estimated fraction of annual energy savings occurring during the APS coincident peak period and is derived from Building America Benchmark Definition[42].

6.3.2 Measure Characterization

6.3.2.1 Applicability

Retrofit

6.3.2.2 Applicable Programs

This measure is applicable to the Multifamily Energy Efficiency Program and Home Performance with ENERGY STAR® Program.

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[42] "Building America Research Benchmark Definition." http://www.nrel.gov/docs/fy10osti/47246.pdf

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6.3.2.3 Measure Description

This low flow device measure promotes energy efficient hot water consumption in residences. Low flow faucet aerators and low flow showerheads reduce the flow rate at which hot water is consumed and ultimately the volume of hot water consumed.

6.3.2.4 Baseline Equipment Definition

The baseline low flow device is based on historical appliance standards, measure life, and appliance availability in the market. The current showerhead value is a blend between a previous appliance standard (4 gpm) and current appliance standards (2.5 gpm).

Specific values are provided in Section 6.3.3.

6.3.2.5 Efficient Equipment Definition

The efficient case refers to Energy Star® certified low flow faucet aerators and showerheads with volumetric flow rates from 1 to 1.5 GPM.

Specific values are provided in Section 6.3.3.

6.3.2.6 Unit Basis

This measure's incentive, savings, and incremental measure cost are determined on a "per device" basis.

6.3.2.7 Effective Useful Life

This measure has an effective useful life of 10 years based on engineering analysis and manufacturer's specifications.

6.3.2.8 Incremental Measure Cost

The incremental cost varies by measure, and is the sum of the full device cost and the associated labor costs. The device costs are weighted averages of the actual devices installed based on program data. Labor costs for this measure category are estimated using $40/hr as the labor rate for MEEP Program and $0/hr for the Home Performance with ENERGY STAR® Program assuming that labor costs are accounted for in the cost of the audit.

See specific values in Section 6.3.3.

6.3.2.9 Energy Savings Algorithm

[illegible]

Where:

ΔkWh	=	Energy savings for this measure (in kWh)
EE_{gpm}	=	Gallons per minute of the efficient case
$Base_{gpm}$	=	Gallons per minute of the baseline case
Occ.	=	No. of occupants per household
GPD	=	Water usage in Gallons per day per person
T_{Used}	=	Water consumption temperature
T_{Mains}	=	Water mains temperature
ISR	=	In-Service Rate
ηDHW	=	Water heater efficiency
No. per unit	=	Number of low flow devices per household
%Elec.	=	Percent of customers with electric water heaters

6.3.2.10 Coincident Peak Demand Savings Algorithm

$$\Delta kW = \Delta kWh \times PDLF$$

Where:

ΔkWh	=	Energy savings for this measure (in kWh)
PDLF	=	Peak demand load fraction

6.3.3 Algorithm Input Values

Table 6-3 shows specific analysis values that are relevant for the MEEP Program and Table 6-4 shows those relevant to the Home Performance with ENERGY STAR® Program in 2016. Baseline flow rates and costs change year to year due to federal standards and the market. Other values are also subject to change as more recent data is collected.

Navigant aligns the values listed here with implementation tracking data to calculate weighted average savings for all faucet aerators rebated through the program. These weighted averages serve as the basis for APS tracked savings. Faucet aerators are not included in the HPwES program in 2016.

Table 6-3. MEEP Program Low Flow Device Analysis Values

Model Category	Baseline Water Usage	Efficient Water Usage	No. of Occupants	Gal/ day/ person	T used (F)	T Mains (F)	In-Service Rate	Percent Electric Water Heating	No. per household	Minutes avoided	Electric Efficiency	PDLF	Incr Costs (per device)
Kitchen Aerator	2.2	1.50	2.7	5.42	95	78.8	90%	100%	1	0	0.9	7.944E-05	$6.90
Bath Aerator	2.2	1.00	2.7	2.91	95	78.8	86%	100%	2	0	0.9	7.944E-05	$5.84
Low flow Showerheads	2.5	1.50	2.7	9.33	95	78.8	96%	100%	1	1	0.9	2.01E-05	$32.20

Table 6-4. Home Performance with ENERGY STAR® Program Low Flow Device Analysis Values

Model Category	Baseline Water Usage	Efficient Water Usage	No. of Occupants	Gal/ day/ person	T used (F)	T Mains (F)	In-Service Rate	Percent Electric Water Heating	No. per household	Minutes avoided	Electric Efficiency	PDLF	Incr Costs (per device)
Low flow Showerheads	2.5	1.56	2.5	9.33	95	78.8	65%	41%	1	1	0.9	2.01E-05	$16.57

6.4 New Construction Measures

6.4.1 Builder Option Packages Baseline and Program Home Descriptions

Savings for this measure are determined using energy simulation modeling. These models are calibrated to monthly energy billing data. The efficient-case building characteristics are averaged for each builder option package as necessary.

Average participant building characteristics generally exceed minimum requirements and savings are specific to each project as local building codes vary, the combination of measures may vary, and the building size may vary. Table 6-5 compares some primary building characteristics between a non-participant building in downtown Phoenix and the average participant characteristics. Refer to the MAS for more detailed modeling assumptions.

Table 6-5. Average Building Characteristics by Model Category

Model Category	Insulation			Windows		Cooling Efficiency (SEER)	Infiltration (ACH)	Duct Leakage	Lighting Power Density (W/ft2)	HERS Score
	Ceiling R-Value	Floor R-Value	Wall R-Value	U-Value	SHGC					
Baseline[43]	38	19	16	0.55	0.38	14	0.29	2.7%	0.31	-
BOP1	38	19	23	0.4	0.25	14	0.33	4.25%	0.49	70
BOP2	38	19	23	0.4	0.25	14	0.33	3.50%	0.40	65
BOP3	38	19	23	0.4	0.25	15	0.29	2.75%	0.33	60

6.4.1.1 Non-Participant Unit

The non-participant unit is defined as the baseline condition for estimating savings for the Multifamily Energy Efficiency Program, and represents an average dwelling unit in a multifamily building built outside of the program. The non-participant building is based on local building codes[44].

See Table 6-5 for specific building characteristics.

6.4.1.2 Builder Option Package 1 (BOP1)

Builder Option Package 1 (BOP1) is a dwelling unit in an entry-level participating multifamily building built and incentivized in the Multifamily Energy Efficiency Program. For builders participating through the prescriptive path, the building meets or exceeds the minimum requirements for the program with *one* additional efficiency building option[45]. For builders participating through the performance path, the building meets or exceeds a HERS rating of 70.

See Table 6-5 for specific building characteristics.

6.4.1.3 Builder Option Package 2 (BOP2)

Builder Option Package 2 (BOP2) is a dwelling unit in a mid-level participating multifamily building built and incentivized in the Multifamily Energy Efficiency Program. For builders participating through the prescriptive path, the building meets or exceeds the minimum requirements for the program with *two*

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[43] The deemed baseline for 2014 is IECC 2012. The building code for downtown Phoenix was designed using IECC 2006 until July 1st, 2013, when the city moved to IECC2012. Building code compliance is assumed to take two years, where builders achieve 50% compliance each year.

[44] The building code for downtown Phoenix was designed using IECC 2006 until July 1st, 2013, when the city moved to IECC2012. Building code compliance is assumed to take two years, where builders achieve 50% compliance each year.

[45] See the link for "new construction and major renovation" at the website http://www.aps.com/en/business/savemoney/rebates/Pages/meep.aspx.

additional efficiency building options [46]. For builders participating through the performance path, the building meets or exceeds a HERS rating of 65.

See Table 6-5 for specific building characteristics.

6.4.1.4 Builder Option Package 3 (BOP3)

Builder Option Package 3 (BOP3) is a dwelling unit in a top-level participating multifamily building built and incentivized in the Multifamily Energy Efficiency Program. For builders participating through the prescriptive path, the building meets or exceeds the minimum requirements for the program with *three* additional efficiency building options [47]. For builders participating through the performance path, the building meets or exceeds a HERS rating of 60.

See Table 6-5 for specific building characteristics.

6.4.2 Measure Characterization

6.4.2.1 Applicability

New Construction

6.4.2.2 Applicable Programs

This measure is applicable to the Multifamily Energy Efficiency Program.

6.4.2.3 Measure Description

This program promotes energy efficient multifamily construction. Builders can participate in the program in one of two ways. Builders can meet or exceed prescriptive construction specifications (prescriptive path), or meet or exceed a home energy rating called a HERS rating (performance path).

The prescriptive specifications are comparable to Energy Star ®'s multifamily new construction guidelines. These specifications include the following:

- improved insulation
- high-efficiency heating and cooling systems
- energy-efficient low-E windows
- tight construction and ducts
- energy-efficient lighting and appliances
- fresh air ventilation and room pressure balancing for improved indoor air quality
- independent test and inspections

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[46] See the link for "new construction and major renovation" at the website http://www.aps.com/en/business/savemoney/rebates/Pages/meep.aspx.
[47] See the link for new construction and major renovation at the website http://www.aps.com/en/business/savemoney/rebates/Pages/meep.aspx.

There are minimum building specifications that all participants must meet as well as additional efficiency options. The three levels of BOP require 1, 2, and 3 additional options respectively.

A HERS rating is based on RESNET®'s home energy rating system, and corresponds to the percent of a standard reference building's energy consumption that the building of interest will consume. A rater creates a model of the building in RESNET®'s REM/Rate modeling software, and the software outputs the building's rating. Each builder option package (BOP1, BOP2, and BOP3) has a different HERS target, where BOP3 is the most efficient option package.

6.4.2.4 Baseline Equipment Definition

The baseline is a dwelling unit in a newly constructed multifamily building within the APS service territory that does not receive a rebate through the Multifamily Energy Efficiency Program. These buildings are based on local building codes [48].

See Table 6-5 for specific building characteristics.

6.4.2.5 Efficient Equipment Definition

The efficient case refers to a dwelling unit in a newly constructed multifamily building rebated through the APS Multifamily Energy Efficiency Program. Building characteristics are averaged from program data to estimate savings for each builder option package.

See Table 6-5 for specific building characteristics.

6.4.2.6 Unit Basis

This measure's incentive, savings, and incremental measure cost are determined on a "per dwelling unit" basis.

6.4.2.7 Effective Useful Life

This measure has an effective useful life of 20 years based on engineering analysis and consistent with the estimated lifetime of the Residential New Construction program.

6.4.2.8 Incremental Measure Cost

The incremental cost for this measure varies depending on builder option package, unit size and the combination of energy efficient measures installed. These costs are based on internet research comparing the cost of participant and non-participant construction components and materials.

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[48] The building code for downtown Phoenix was designed using IECC 2006 until July 1st, 2013, when the city moved to IECC2012. Building code compliance is assumed to take two years, where builders achieve 50% compliance each year.

For specific incremental costs, refer to the MAS. For average costs by builder option package, refer to Section 6.4.3.

6.4.2.9 Annual Energy Savings Algorithm

Energy and coincident peak demand savings are based on calibrated DOE-2 simulation models. DOE-2[49] is industry accepted software for modeling building energy consumption and accounts for interactive effects between energy efficiency measures.

The following algorithm is used to estimate annual energy saving impacts from this measure.

$$\Delta kWh = kWh_{Base} - kWh_{EE}$$

Where:

ΔkWh	= Energy savings for this measure (in kWh)
kWh_{Base}	= Annual energy consumption of the average baseline/ non-participant unit
kWh_{EE}	= Annual energy consumption of the average participant dwelling unit

6.4.2.10 Coincident Peak Demand Savings Algorithm

Hourly simulation outputs are used to estimate the difference in baseline and participant coincident peak demand. The following algorithm is used to estimate program impacts on coincident peak demand.

$$\Delta kW_{Coincident} = kW_{Base} - kW_{EE}$$

Where:

$\Delta kW_{coincident}$	= Coincident peak demand savings for this measure (in kW)
kW_{Base}	= Annual coincident peak demand of the average baseline/non-participant unit
kW_{EE}	= Annual coincident peak demand of the average participant dwelling unit

6.4.3 Algorithm Input Values

Table 6-6 compares energy consumption, coincident demand, and the incremental cost between non-participant and participant buildings in downtown Phoenix. These values are subject to change depending on the mix of efficiency measures, the location of participant buildings, and changes in building codes.

[49] DOE-2 is a public software program that performs advanced building energy simulations, and can be found at: http://doe2.com/

Table 6-6. Annual Energy Consumption, Coincident Demand, and Costs by Builder Option Package

Model Category	Annual Energy Consumption (kWh)	Coincident Demand (kW)	Incremental Costs (per unit)
Baseline[50]	7,411	1.515	-
BOP1	5,875	1.23	$568
BOP2	5,252	1.11	$648
BOP3	4,539	0.85	$903

[50] The deemed baseline for 2013 is a 25/75 weighted average between IECC 2012 and IECC 2006 respectively. The building code for downtown Phoenix was designed using IECC 2006 until July 1st, 2013, when the city moved to IECC2012. Building code compliance is assumed to take two years, where builders achieve 50% compliance each year.

7. RESIDENTIAL BEHAVIORAL PROGRAM

The Residential Behavioral Program is implemented by Opower and provides participating Residential customers with a bi-monthly Home Energy Report (HER). HERs contain information designed to motivate customers to change their energy usage behavior in order to save energy. The program is implemented as a Randomized Controlled Trial (RCT), such that new program waves consist of customers randomly assigned to treatment and control in order to arrive at unbiased estimates of program savings using regression analysis. Billing analysis is performed using monthly billing data to compare treatment and control group usage and determine program savings.

Beginning in July of 2016, some existing HER customers were randomly selected by Opower and assigned to Behavioral Demand Response (BDR) in addition to receiving HER reports. The BDR component of the Residential Behavior Program is additional to existing HER treatment, and is itself implemented as an RCT. Through the BDR component, the implementer calls events during peak summer usage days, requesting that participants curb their energy use during particular periods of time. This reduces peak load, and customers receive feedback on their demand reduction performance relative to other BDR participants. A variant billing analysis model is used by the implementer to estimate savings from the BDR component of the Residential Behavior Program.

7.1 Program Definitions and Algorithm Input Descriptions

The following sections define key terms used in the discussion and characterization of savings and costs for the Residential Behavioral Program.

7.1.1 Control Group

The control group for the Residential Behavior Program consists of residential customers that *do not* receive HERs. The monthly energy consumption profile of the control group *prior to program launch* is consistent with that of the treatment group (see section 7.1.2 for definition). The control group is sub-divided into five groups; Legacy, Refill, New Refill, Expansion, and New Expansion Group controls (see sections 7.1.3 through 7.1.7 for definitions).

For the BDR component of the Residential Behavior Program, the control group consists of residential customers that *do not* receive communication asking them to curb energy use during specified peak demand periods, and therefore receive no feedback on their energy use curtailment performance during peak events. As with the HER component of the program, the monthly energy consumption profile of the control group prior to program launch is consistent with that of the treatment group. The 2016 wave BDR control group is defined in section 7.1.8.

7.1.2 Treatment Group

The treatment group for the Residential Behavior Program consists of residential customers that receive home energy reports. The treatment group is sub-divided into four groups of participants; Legacy, Refill, New Refill, Expansion, and New Expansion Group participants.

For the BDR component of the Residential Behavior Program, the treatment group consists of residential customers that do receive communication asking then to curb energy use during specified peak demand periods, and subsequent feedback on their performance during events. The treatment group for the 2016 BDR wave is defined in section 7.1.8).

7.1.3 Legacy Group

The Legacy Group consists of both treatment customers and control customers. The treatment group is composed of approximately 60,000 program participants that began receiving home energy reports in 2011, of which approximately 51,000 are still participating in the program as of December 2015. Of these 51,000 participants, approximately 50,000 are receiving BDR treatment in addition. The control group is comprised of approximately 42,000 customers who serve as controls for Legacy Group treatment customers, and do not receive reports.

7.1.4 Refill Group

The Refill Group consists of both treatment customers and control customers. The treatment group is comprised of approximately 13,000 program participants that began receiving home energy reports in 2012 to replace those from the original Legacy Group that opted out of the program or are no longer in the program. Approximately 11,000 of these Refill Group participants are still participating in the program as of December 2015. Of these 11,000 participants, approximately 11,000 are receiving BDR treatment in addition. The control group is comprised of approximately 10,000 customers who serve as controls for Refill Group treatment customers, and do not receive reports.

7.1.5 New Refill Group

The New Refill Group consists of both treatment customers and control customers. The treatment group is composed of approximately 31,000 program participants that began receiving home energy reports in 2014 to replace those from the original Legacy Group and the Refill Group that opted out of the program or are no longer in the program. Approximately 24,000 of these New Refill Group participants are still participating in the program in December 2015. Of these 24,000 participants, approximately 24,000 are receiving BDR treatment in addition. The control group is comprised of approximately 12,000 customers who serve as controls for New Refill Group treatment customers, and do not receive reports.

7.1.6 Expansion Group

The Expansion Group consists of both treatment customers and control customers. The treatment group is composed of approximately 207,000 program participants that began receiving home energy reports in 2015 to replace those from the original Legacy Group, the Refill Group and the New Refill Group that opted out of the program or are no longer in the program. Approximately 178,000 of these Expansion Group participants are still participating in the program in December 2015. Of these 178,000 participants, approximately 176,000 are receiving BDR treatment in addition. The control group is comprised of approximately 20,000 customers who serve as controls for Expansion Group treatment customers, and do not receive reports.

7.1.7 New Expansion Group

The New Expansion Group consists of both treatment customers and control customers. The treatment group is composed of approximately 45,000 program participants that began receiving home energy reports in 2016 to replace those from the original Legacy Group, the Refill Group, the New Refill, and the New Expansion Group that are no longer in the program due to move outs. All of these participants are receiving BDR treatment in addition. The control group is composed of approximately 13,000 customers who serve as controls for New Expansion Group treatment customers, and do not receive reports.

7.1.8 2016 BDR Group

The 2016 BDR Group consists of both treatment and control customers. The treatment group is composed of approximately 53,000 program participants that will begin receiving communication and participating in demand curtailment events during peak demand events called during Summer, 2016. This treatment group is composed of customers already participating in the main HER component of the Residential Demand Program, who are then additionally exposed to BDR messaging. The control group is composed of approximately 23,000 customers, also drawn from existing HER groups, who serve as controls for the 2016 BDR Group treatment customers, and do not receive BDR messaging and communications. It is important to note that these customers are a subset of the customers described in Sections 7.1.3 through 7.1.7 that receive BDR treatment on top of existing HER treatment. These 53,000 treatment and 23,000 control BDR customers are already accounted for in the current participant totals given in Sections 7.1.3 through 7.1.7.

7.1.9 Joint Savings Adjustment Factor

The Joint Savings Adjustment Factor (JSAF) accounts for savings already claimed through other programs to prevent double counting of savings. The JSAF is based on a comparison of participation in other APS EE programs between the control and treatment groups. This analysis estimates the savings resulting from a "lift" in other programs. The JSAF is the ratio of program savings less those from this "lift" to program savings directly estimated through regression analysis.

7.2 Measure Characterizations

7.2.1 Home Energy Reports

7.2.1.1 Applicability

Retrofit

7.2.1.2 Applicable Programs

This measure is only applicable to the Residential Behavioral Program.

7.2.1.3 Measure Description

The Residential Behavioral Program provides participating Residential customers with bi-monthly reports called HERs containing information designed to motivate them to change their energy usage behavior to save energy.

To drive conservation behavior, this program direct mails comparative Home Energy Reports to participants that show how the energy usage in that customer's home compares with similar homes.

Coupled with the comparison data, customers receive recommendations for specific and targeted actions they can take to save energy.

Derived from best practices in behavioral science research, this program uses the power of normative messaging to successfully engage and motivate conservation actions of targeted individuals. Comparing an individual's energy use to what is "normal" has proven to be an effective mechanism to attract attention and motivate action. Normative messaging on energy use, combined with recommendations on how to improve, comprise the basic approach of this program. The program provides a benchmark for customers to achieve, and instills a sense of competition to produce sustained conservation behaviors.

In 2016, in addition to receiving HERs, approximately 53,000 existing Residential Behavior Program customers were randomly selected by the implementer to comprise the 2016 BDR Group. This group will receive communication from the implementer when peak demand reduction events are called during hot summer months in order to curb their energy use and reduce peak demand overall. BDR Group participants will receive follow-up messaging communicating how well they performed relative to others in terms of reducing their demand during each peak demand event. As with the HER component of the program, the basis for BDR messaging is also leveraging competition and social norming in order to encourage customers to change their energy use behavior. However, whereas the HER component does not specify when or how customers are to reduce energy usage, the BDR component targets specific periods of time during which customers are asked to curtail energy use.

7.2.1.4 Baseline Definition

The baseline in the case of the HER component of the program is a group of residential customers that *do not* receive home energy reports, also referred to as the "control group." The monthly energy consumption profile of the control group *prior to program launch* is consistent with that of the APS customers that receive the reports, also referred to as the "treatment group." Each group (Legacy, Refill, New Refill, Expansion, and New Expansion) has its own control group which serves as its baseline.

The meaning of baseline with respect to the BDR component of the program is identical—the BDR component is also composed of treatment and control groups. Both BDR treatment and control groups receive HER reports, but the BDR treatment group also receives BDR messaging, whereas the BDR baseline group does not receive BDR messaging. The BDR control group serves as a baseline energy usage level against which to measure the additional energy and demand savings attributable to the BDR component of the program over and above existing HER savings.

7.2.1.5 Efficient Definition

The efficient case for the HER program component (i.e. those participating in the HER program component) is a group of residential customers that receive HERs, also referred to as the "treatment group." The treatment group is sub-divided into Legacy, Refill, New Refill, Expansion, and New Expansion Group participants. The efficient case for the BDR program component is a group of existing Residential Behavior Program customers that receive BDR messaging and communications in addition to HERs.

Per participant savings estimates are based on the weighted average of Legacy, Refill, New Refill, Expansion, and New Expansion Group participants plus additional incremental savings contributed by the BDR program component.

7.2.1.6 Unit Basis

This measure's savings and incremental measure cost are determined on a "per participant" basis.

7.2.1.7 Effective Useful Life

This measure has an effective useful life of 1 year under the conservative assumption that savings are primarily due to behavioral modifications and do not persist after a participant stops receiving the HERs.

7.2.1.8 Incremental Measure Cost

There is no incremental measure cost associated with this program under the assumption that savings are driven by behavioral changes with no cost to the participant.

7.2.1.9 Annual Energy Savings Algorithm

Program savings are determined from a statistical comparison of monthly billing data between a control group and a treatment group. The model outputs have been verified through the MER process.

The following algorithm is used to estimate annual energy saving impacts from this measure.

$$\Delta kWh = \left[\Delta kWh_{Leg} \times \%_{Leg} + \Delta kWh_{Refill} \times \%_{Refill} + \Delta kWh_{NewRef} \times \%_{NewRef} + \Delta kWh_{Expan} \times \%_{Expan} + \Delta kWh_{NewExpan} \times \%_{NewExpan}\right] \times BAF$$

Where:

ΔkWh	= Annual kWh energy savings for this measure
ΔkWh_{Leg}	= Annual kWh energy savings for a Legacy participant
$\%_{Leg}$	= Percent of total program participants in the Legacy group
ΔkWh_{Refill}	= Annual kWh energy savings for a Refill participant
$\%_{Refill}$	= Percent of total program participants in the Refill group
ΔkWh_{NewRef}	= Annual kWh energy savings for a New Refill participant
$\%_{NewRef}$	= Percent of total program participants in the New Refill group
ΔkWh_{Expan}	= Annual kWh energy savings for an Expansion Group participant
$\%_{Expan}$	= Percent of total program participants in the Expansion Group
$\Delta kWh_{NewExpan}$	= Annual kWh energy savings for a New Expansion Group participant
$\%_{NewExpan}$	= Percent of total program participants in the New Expansion Group

$JSAF$ = Joint Savings Adjustment Factor

7.2.1.10 Coincident Peak Demand Savings Algorithm

Coincident peak demand savings are estimated by equally distributing energy savings in July and August across each hour of the two month period. The following algorithm is used to estimate program impacts for coincident peak demand.

$$\Delta kW_{CoincidentPeak} = \frac{\Delta kWh_{July} + \Delta kWh_{Aug}}{(24 * 62)} x JSAF$$

Where:

ΔkWh_{July} = Weighted monthly energy savings for July for Legacy and Refill Group

ΔkWh_{Aug} = Weighted monthly energy savings for August for Legacy and Refill Group

$JSAF$ = Joint Savings Adjustment Factor

7.3 Algorithm Input Values

Table 7-1 and Table 7-2 displays the inputs to the algorithm above to estimate "per participant" savings for recipients of the home energy reports. These values are derived from a statistical regression model based on annual monthly consumption for the control and treatment groups through September 2015.

Table 7-1. Algorithm Inputs for Home Energy Reports

Measure	Home Energy Reports	Home Energy Reports with BDR
ΔkWh_{Leg}	311	363
$\%_{Leg}$	0.19	0.17
$\Delta kWh_{RefFill}$	305	338
$\%_{RefFill}$	0.04	0.04
$\Delta kWh_{[illegible]}$	447	540
$\%_{[illegible]}$	0.09	0.08
ΔkWh_{Expan}	129	149
$\%_{Expan}$	0.67	0.56
$\Delta kWh_{[illegible]}$	TBD	TBD
$\%_{[illegible]}$	TBD	TBD

Table 7-2. Algorithm Inputs for Home Energy Reports

Measure	[illegible]	[illegible]	[illegible]
Home Energy Reports			0.977
Home Energy Reports with BDR	TBD[51]	TBD	0.977

[51] HER value with BDR

8. RESIDENTIAL PREPAID ENERGY CONSERVATION PILOT PROGRAM

The Residential Prepaid Energy Conservation Pilot Program ("Prepay Program") is an alternative to traditional monthly billing that allows the customer to deposit funds into an account on an ongoing basis rather than wait for a monthly bill. As the customer uses electricity, the account balance diminishes. The customer then deposits additional funds and continues consuming electricity without a break in service. The program provides customers the opportunity to control the pace at which they consume electricity. Program savings are determined through a statistical comparison of monthly billing data between a treatment group and a matched control group.

8.1 Program Definitions and Algorithm Input Descriptions

The following sections define key terms used in the discussion and characterization of savings and costs for the Prepay Program.

8.1.1 Conservation Effect

The conservation effect is the average reduction in energy consumption associated with participant enrollment in the Prepay Program. The conservation effect comprises three distinct sub-effects: the DSM program effect, the disconnect effect and the behavior effect (see definitions 8.1.28.1.38.1.4).

8.1.2 DSM Program Effect

The DSM program effect is the average reduction in energy consumption associated with Prepay Program participants' involvement in other DSM programs during their period of enrollment in the Prepay Program. The DSM program effect must be subtracted from the conservation effect in order to avoid double-counting savings attributable to other DSM programs.

8.1.3 Disconnect Effect

The disconnect effect refers to the average reduction in energy consumption due to Prepay Program participants' having their electricity service interrupted as a result of not maintaining a positive balance of funds in their account. The disconnect effect is subtracted from the conservation effect in order to estimate savings attributable to the Prepay Program.

8.1.4 Behavior Effect

The behavior effect refers to the average reduction in energy consumption associated with participant enrollment in the Prepay Program, not inclusive of DSM program effects and disconnect effects. The behavior effect is calculated by subtracting both the DSM program and disconnect effects from the conservation effect. Savings due to the behavior effect are claimed by APS as Prepay Program savings.

8.1.5 Annual Energy Consumption

The average annual energy consumption in kWh of program participants prior to their participation in the Prepay Program. This value is based on monthly billing data for program participants and was determined as part of a 2014 Navigant study of APS's Prepay Pilot program[52]. Annual energy savings are calculated by multiplying the annual energy consumption by the behavior effect.

8.1.6 Peak Demand

The peak demand in kW of program participants occurring during the coincident peak period prior to their participation in the Prepay Program. Peak demand was determined by analyzing pre-program hourly interval data for participants for the coincident peak period, (i.e., weekdays July-August, from 4-6 p.m.) as part of the 2014 Navigant study.

8.2 Measure Characterizations

8.2.1 Prepay Accounts

8.2.1.1 Applicability

Retrofit

8.2.1.2 Applicable Programs

This measure is only applicable to the Prepay Program.

8.2.1.3 Measure Description

Through the Prepay Program, APS Residential customers pay for their electricity consumption from a prepay account, rather than receiving and paying a monthly electric utility bill. As the customer consumes electricity, funds are deducted from the account to pay for the electricity used. Prepay Program participants periodically deposit funds into their prepay account in order to maintain uninterrupted electric service.

Based on best practices in behavioral science research, this program utilizes the power of feedback messaging to successfully engage Prepay participants in energy use conservation behaviors. The ability to monitor the availability of funds and energy use via a web portal and balance alerts motivates participants to control the pace at which they consume electricity from APS. The direct and visible link between electricity use and the funds available in their prepay account is hypothesized to spur conservation behavior. For example, customers who are aware that they may not be able to deposit more funds into the prepay account in the near term may reduce electricity use accordingly in order to avoid experiencing a disconnect event.

[52] "Impact Evaluation of Arizona Public Services' Prepay Pilot," Prepared for Arizona Public Services by Navigant Consulting, July, 2014.

8.2.1.4 Baseline Definition

The baseline condition is defined as the energy consumption of residential customers that do not participate in the Prepay Program. To estimate the baseline condition, Navigant's 2014 impact evaluation of the Prepay Program employed a matching algorithm to develop a "matched control group." This group of non-participating customers, has a monthly energy consumption profile *prior to program launch* consistent with that of the treatment group (see Section 8.2.1.5), and therefore serves as a proxy for the baseline condition.

8.2.1.5 Efficient Definition

The efficient case (i.e. those participating in the program) is the energy consumption of residential customers that participate in the Prepay Program, also referred to as the "treatment group." The treatment group customers deposit and maintain funds in a prepay account which is debited to pay for electricity use, rather than receiving and paying a monthly electricity bill.

8.2.1.6 Unit Basis

This measure's savings, and incremental measure cost are determined on a "per participant" basis.

8.2.1.7 Effective Useful Life

This measure has an effective useful life of 1 year under the conservative assumption that savings are primarily due to behavioral modifications and do not persist after a participant stops participating in the Prepay Program, resuming regular monthly billing to pay for electricity use.

8.2.1.8 Incremental Measure Cost

There is no incremental measure cost associated with this program under the assumption that savings are driven by behavioral changes with no cost to the participant.

8.2.1.9 Annual Energy Savings Algorithm

Annual energy savings were determined based on a statistical comparison of monthly billing data between a matched control group and a treatment group in studies of the Prepay Pilot program conducted by Navigant in 2014 and 2015[53]. Per participant savings estimates are based on the behavior effect of 7.2%, calculated in the 2014 impact evaluation study as the conservation effect less the DSM program and disconnect effects. Annual energy savings are the result of multiplying the annual energy consumption of participants prior to program participation by the behavior effect.

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[53] "APS Prepay Program Updated Disconnect Analysis-DRAFT," Prepared for Arizona Public Services by Navigant Consulting, November, 2015.

The following algorithm is used to estimate annual energy saving impacts from this measure.

$$\Delta kWh = \%_{Behav} * kWh_{annual} = (\%_{Conserv} - (\%_{DSMprog} + \%_{Discon})) * kWh_{annual}$$

Where:

ΔkWh	= Annual energy savings (in kWh) for this measure
$\%_{Behav}$	= Annual percent energy savings due to the behavior effect
kWh_{annual}	= Average annual energy consumption (in kWh) of program participants prior to participating in the PrePay Program.
$\%_{Conserv}$	= Annual percent energy savings due to the conservation effect
$\%_{DSMprog}$	= Annual percent energy savings due to the DSM program effect
$\%_{Discon}$	= Annual percent energy savings due to the disconnect effect

8.2.1.10 Coincident Peak Demand Savings Algorithm

Coincident demand savings are calculated as the average of two approaches. The first approach assumes the average per participant annual energy savings impact net of disconnects and DSM programs is distributed equally throughout every hour of the year. The second approach assumes the percent savings effect is consistent through every hour of the year.

The following algorithm is used to estimate program impacts for coincident peak demand.

$$\Delta kW_{CoincPeak} = Average\ ((\%_{Behav} * kW_{Peak}) + (\Delta kWh/8760))$$

Where:

$\Delta kWh_{CoincPeak}$	= Coincident Peak Demand Savings in kW
$\%_{Behav}$	= Percent energy savings due to the behavior effect
kW_{Peak}	= Coincident Peak Demand for program participants in kW
ΔkWh	= Annual energy savings (in kWh) for this measure

8.3 Algorithm Input Values

Table 8-1 displays the inputs to the algorithm above to estimate "per participant" savings for customers enrolled in the Prepay Program.

The conservation effect is derived from a statistical regression model based on annual monthly consumption for the control and treatment groups between July 2012 and December 2013. The DSM program effect is derived through statistical comparison of matched control versus treatment group participation in other DSM programs during the treatment period. The disconnect effect is based on statistical comparison of disconnect events experienced by the treatment group and the matched control group during the treatment period. The behavior effect, the percentage savings value used as the Prepay Program deemed savings value, is calculated using the conservation effect, the DSM program effect and the disconnect effect, according to the equation given in Section 8.2.1.9.

Table 8-1. Algorithm Inputs for Prepaid Energy Conservation Pilot

Measure					Peak Demand (kW)	Annual Energy Consumption (kWh)
Prepay Program	7.16%	7.59%	0.03%	0.40%	3.29	16,488

9. SOLUTIONS FOR BUSINESS - LIGHTING

9.1 Algorithm Inputs

9.1.1 Baseline Wattage (W_{base})

The baseline wattage refers to the connected load of lighting equipment prior to lighting replacements or retrofits. The wattage values vary depending on the type of lighting technology and the size or length of the equipment and are derived from manufacturers' specification and secondary sources.

9.1.2 Efficient Wattage (W_{ee})

The efficient wattage refers to the connected load of lighting equipment after lighting replacements or retrofits. The wattage values vary depending on the type of lighting technology and the size or length of the equipment and are derived from manufacturers' specification and secondary sources.

9.1.3 Hours of Operation (OpHrs)

Annual hours of operation for different measure types are separated by building type and summarized in Table 9-1. Hours for lighting measures are determined from a combination of field metering for high penetration sectors and data from the End-Use Data Acquisition Project (EUDAP) for remaining sectors. Variations are due to different operating conditions for different buildings. Hours of operation values for specific measure types are weighted and averaged accordingly to different recorded building types from historical program participation dating back to Program Year 2008.

9.1.4 Demand Interaction Factor (DIF)

The demand interaction factor is used to account for the fraction of the direct measure demand savings that decrease (or increase) HVAC system demand. For instance, the installation of more efficient lighting systems in conditioned spaces reduce cooling loads and increase heating loads in conditioned spaces resulting in reduced usage of the HVAC system during peak periods of the summer. Demand interaction factors for different building types, determined through calibrated building simulation utilizing TMY weather data for Phoenix, AZ, are summarized in Table 9-1.

9.1.5 Energy Interaction Factor (EIF)

The energy interaction factor is used to account for the fraction of the direct measure energy savings that decrease (or increase) HVAC system consumption. For instance, the installation of more efficient lighting systems reduce cooling loads and increased heating loads in conditioned spaces resulting in reduced usage of the HVAC system during peak periods of the summer. Energy interaction factors for different building types, determined through calibrated building simulation utilizing typical TMY weather data for Phoenix, AZ, are summarized in Table 9-1.

9.1.6 Diversity Factor (DF)

The DF refers to the ratio of the peak demand of a population of units to the sum of the non-coincident peak demands of all individual units and is derived from a field metering study for lighting measures. DFs for different building types are summarized in Table 9-1.

9.1.7 Coincidence Factor (CF)

The CF is the fraction of the peak demand of a population that is in operation at the time of APS' system peak and is derived from a field metering study and analysis of APS' system load. CFs for different building types are summarized in Table 9-1.

9.1.8 Demand Savings Factor (DSF)

The DSF represents the percent savings over baseline energy demand. For instance, the addition of lighting controls may save on load for a system without controls. Values are derived from secondary research.

9.1.9 Energy Savings Factor (ESF)

The ESF represents the percent savings over baseline energy consumption. For instance, the addition of lighting controls may save on consumption for a system without controls. Values are derived from secondary research.

Navigant aligns the values listed in Table 9-1 with historic implementation tracking data to calculate weighted average savings for rebated lighting measures rebated by APS. These weighted averages serve as the basis for APS tracked savings.

Table 9-1. Summary of Common Parameters by Building Type – Lighting

Building Type	OpHrs	CF	DF	DIF	EIF
College/University	3981	0.93	0.90	0.20	0.17
Grocery	6659	0.99	0.90	0.20	0.17
Hotel/Motel	3108	0.50	0.66	0.20	0.17
K-12 School	1835	0.34	0.80	0.02	0.04
Medical	6739	1.00	0.90	0.20	0.17
Miscellaneous	2769	0.65	0.89	0.20	0.17
Office	1804	0.58	0.66	0.20	0.17
Restaurant	5217	0.95	0.90	0.20	0.17
Retail	4431	0.96	0.92	0.20	0.17
Warehouse	3432	0.90	0.90	0.20	0.17
Process Industrial	4481	0.93	0.90	0.20	0.17
Other Industrial	4481	0.93	0.90	0.20	0.17
Data Centers	3432	0.90	0.90	0.20	0.17

9.2 Measure Characterization

9.2.1 T12 to Premium T8/T5; T12 to Standard T8/T5

9.2.1.1 Applicability

Blended combination of Replace on Burnout and Retrofit

Refer to Section 9.2.1.4for further details.

9.2.1.2 Applicable Programs

This measure is applicable to APS' Solutions for Business programs, which include:

» Large Existing
» New Construction
» Small Business
» Schools

9.2.1.3 Measure Description

This lighting end-use measure promotes the replacement of T12 lamps and ballasts as a system (i.e., fixture) with T5 or T8 lamps (i.e., Premium T8/T5 and Standard T8) and electronic ballasts. T5 and T8 lamps provide comparable light output (i.e., lumens) at lower wattages. Electronic ballasts require less wattage than ballasts often used in T12 system (e.g., magnetic ballasts). The measure only incents for replacement of lamps but requires fixtures to have electronic ballasts.

9.2.1.4 Baseline Equipment Definition

The baseline case refers to T12 linear fluorescent lamps with magnetic ballasts.

Due to a series of federal legislation (i.e., Energy Policy Act of 2005, Energy Independence and Security Act of 2007, 2009 Department of Energy ruling) and impending rulemaking (i.e., 2011 Federal Ballast ruling) on setting luminous efficacy and ballast requirements, there is expected to be a phase-out of standard T12 ballasts and lamps. This will eventually impact the baseline fixture wattage when lighting replacements occur with Standard T8 fixtures being the likely option available once stock of T12 lamps are completed phased-out and customers must replace their fixtures with code minimum lamps and ballasts. Scenarios where customers have exhausted T12 lamps and such lamps are depleted from shelves and are therefore required to install T8 lamps are characterized as replacement-on-burnout (i.e., ROB). As current lighting options may vary, customers may gradually move towards the ROB scenario as T12s may slowly become unavailable. For the purposes of this program, this gradual phase-out is being captured through a gradual blended baseline of the T12 and Standard T8 fixtures with each successive program year of implementation. For this program year, the baseline fixture wattage will be a 25:75 ratio between T12 and Standard T8 fixtures representing a blended ROB/RET situation as shown in Table 9-2.

Table 9-2. Blended Fixture Wattage Baseline

Program Year	% T12 Baseline	% Standard T8 Baseline
2013	100%	0%
2014	50%	50%
2015	25%	75%
2016	12.5%	87.5%
2017	0%	100%

9.2.1.5 Efficient Equipment Definition

The efficient case refers toT8/T5 linear fluorescent lamps (either Premium or Standard) with electronic ballasts. Premium T8 lamps or 800-series lamps per the Consortium for Energy Efficiency (CEE) specifications[54] refer to lamps with higher luminous efficacy and part of systems with a qualified, high-efficiency, low-watt electronic ballast. Standard T8 lamps or 700-series lamps do not have CEE lamp specifications but as part of the program requirements must be retrofitted with electronic ballasts.

9.2.1.6 Unit Basis

This measure's incentive, savings, and incremental measure cost are determined on a "per lamp" basis.

9.2.1.7 Effective Useful Life

This measure has an effective useful life of 15 years determined from the DEER 2008[55].

9.2.1.8 Incremental Measure Cost

The incremental cost for this measure varies depending on the lamp type and lamp length and includes the total material and labor costs. Incremental costs are derived from contractor interviews and secondary sources. Incremental costs for different fixture types can be found in Table 9-3.

9.2.1.9 Annual Energy Savings Algorithm

The following algorithm is used to estimate annual energy saving impacts for this measure. Numeric values for the variables can be found in Table 9-3.

[54] http://library.cee1.org/sites/default/files/library/2743/CEE_ComLit_HP_Lighting_Spec.pdf
[55] http://www.deeresources.com/

$$\Delta kWh = \frac{(W_{base} - W_{ee})}{1000} \times OpHrs \times (1 + EIF)$$

Where:

ΔkWh	=	Energy savings for measure (in kWh)
W_{base}	=	Baseline Wattage of Fixture
W_{ee}	=	Efficient Wattage of Fixture
OpHrs	=	Hours of Operation
EIF	=	Energy Interaction Factor

9.2.1.10 Coincident Peak Demand Savings Algorithm

The following algorithm is used to estimate annual coincident peak demand saving impacts for this measure. Numeric values for the variables can be found in Table 9-3.

$$\Delta kW_{coincident} = \frac{(W_{base} - W_{ee})}{1000} \times (1 + DIF) \times DF \times CF$$

Where:

$\Delta kW_{coincident}$	=	Coincident peak demand savings for this measure (in kW)
W_{base}	=	Baseline Wattage of Fixture
W_{ee}	=	Efficient Wattage of Fixture
DIF	=	Demand Interaction Factor
DF	=	Diversity Factor
CF	=	Coincidence Factor

9.2.1.11 Algorithm Input Values by Measure

The values presented in the following table are based on historical participation data for the Solutions for Business programs. Values are weighted averages based on the sector-specific values presented in Table 9-1.

Table 9-3. Measure Lookup Values – Linear Fluorescents

Measure Sub-Category	Measure	OpHrs	DIF	EIF	CF	DF	W_{base}	W_{ee}	Incremental Cost ($/lamp)
T12 to Premium T8/T5	2-foot lamp	3000	0.15	0.13	0.65	0.80	26.9	14.0	$21.69
T12 to Premium T8/T5	3-foot lamp	3000	0.15	0.13	0.65	0.80	42	18.3	$29.01
T12 to Premium T8/T5	4-foot lamp	3000	0.15	0.13	0.65	0.80	39.3	21.6	$23.29
T12 to Premium T8/T5	8-foot lamp	3000	0.15	0.13	0.65	0.80	81	58.1	$27.71
T12 to Standard T8/T5	2-foot lamp	3204	0.17	0.14	0.69	0.82	26.9	18	$35.66
T12 to Standard T8/T5	3-foot lamp	3204	0.17	0.14	0.69	0.82	42	23.5	$40.71
T12 to Standard T8/T5	4-foot lamp	3204	0.17	0.14	0.69	0.82	39.3	27.7	$25.12
T12 to Standard T8/T5	8-foot lamp	3204	0.17	0.14	0.69	0.82	81	60	$39.06

9.2.2 T8 to Premium T8

9.2.2.1 Applicability

Retrofit

9.2.2.2 Applicable Programs

This measure is applicable to APS' Solutions for Business programs, which include:

- Large Existing
- New Construction
- Small Business
- Schools

9.2.2.3 Measure Description

This lighting end-use measure promotes the replacement of Standard 4-foot T8 lamps and ballasts as a system (i.e., fixture) with 4-foot Premium T8 lamps and electronic ballasts. T8 lamps provide comparable light output (i.e., lumens) at lower wattages. The measure only incents for replacement of lamps but requires fixtures to have electronic ballasts.

9.2.2.4 Baseline Equipment Definition

The baseline case refers to 4-foot Standard T8 lamps with electronic ballasts.

9.2.2.5 Efficient Equipment Definition

The efficient case refers to 4-foot Premium T8 lamps as defined by CEE specifications[56] with electronic ballasts.

9.2.2.6 Unit Basis

This measure's incentive, savings, and incremental measure cost are determined on a "per lamp" basis.

9.2.2.7 Effective Useful Life

This measure has an effective useful life of 15 years determined from DEER 2008[57].

9.2.2.8 Incremental Measure Cost

The incremental cost for this measure varies depending on the number of lamps in the fixture configuration and includes the total material and labor costs. Incremental costs are derived from contractor interviews and secondary sources. Specific incremental costs for different fixture types can be found in Table 9-4.

9.2.2.9 Annual Energy Savings Algorithm

The following algorithm is used to estimate annual energy saving impacts for this measure. Numeric values for the variables can be found in Table 9-4.

$$\Delta kWh = \frac{(W_{base} - W_{ee})}{1000} \times OpHrs \times (1 + EIF)$$

Where:

ΔkWh	=	Energy savings for measure (in kWh)
W_{base}	=	Baseline Wattage of Fixture
W_{ee}	=	Efficient Wattage of Fixture
OpHrs	=	Hours of Operation
EIF	=	Energy Interaction Factor

[56] http://library.cee1.org/sites/default/files/library/2743/CEE_ComLit_HP_Lighting_Spec.pdf

[57] http://www.deeresources.com/

9.2.2.10 Coincident Peak Demand Savings Algorithm

The following algorithm is used to estimate annual coincident peak demand saving impacts for this measure. Numeric values for the variables can be found in Table 9-4.

$$\Delta kW_{coincident} = \frac{(W_{base} - W_{ee})}{1000} \times (1 + DIF) \times DF \times CF$$

Where:

$\Delta kW_{coincident}$	=	Coincident peak demand savings for this measure (in kW)
W_{base}	=	Baseline Wattage of Fixture
W_{ee}	=	Efficient Wattage of Fixture
DIF	=	Demand Interaction Factor
DF	=	Diversity Factor
CF	=	Coincidence Factor

9.2.2.11 Algorithm Input Values by Measure

The values presented in the following table are based on historical participation data for the Solutions for Business programs. Values are weighted averages based on the sector-specific values presented in Table 9-1.

Table 9-4. Measure Lookup Values – T8 to Premium T8

Measure Sub-Category	Measure	OpHrs	DIF	EIF	CF	DF	W_{base}	W_{ee}	Incremental Cost ($/lamp)
T8 to Premium T8	4-foot lamp	4481	0.16	0.14	0.93	0.75	27.7	21.6	$17.62

9.2.3 High Intensity Discharge (HID) to Linear Fluorescent Retrofit

9.2.3.1 Applicability

Retrofit

9.2.3.2 Applicable Programs

This measure is applicable to APS' Solutions for Business programs, which include:

- Large Existing
- New Construction
- Small Business
- Schools

9.2.3.3 Measure Description

This lighting end-use measure promotes the replacement of High Intensity Discharge (HID) fixtures with new T5 or T8 fixtures that must contain at least two lamps and an electronic ballast.

9.2.3.4 Baseline Equipment Definition

The baseline case refers to HID fixtures that include Metal Halides (MH) and High Pressure Sodium (HPS) fixtures with varying lamp wattages from 150 watts up to 1,000 watts.

9.2.3.5 Efficient Equipment Definition

The efficient case refers to T5HO or T8/T8HO fixtures with number of lamps per fixture ranging from two lamps up to 12 lamps. To ensure that the efficient equipment reduces the connected load, Table 9-5 shows the following baseline-efficient equipment retrofit combinations that are allowed.

Table 9-5. HID to Linear Fluorescent Retrofit Combination Types

Baseline Fixture Type	Efficient Fixture Type
150W lamp HID	2-lamp 4ft T5HO/T8, 4-lamp 2ft T5HO, or T8 linear
175W lamp HID	2-lamp 4ft linear or 4-lamp 2ft linear
250W lamp HID	3-lamp 4ft T5HO, 3-lamp T8 linear, or 4-lamp T8 linear
400W lamp HID	6-lamp T5HO linear
400W lamp HID	4-lamp T5HO or 6-lamp T8 linear
750W lamp HID	6-lamp T8 linear, (2) 4-lamp T5HO linear, or (2) 6-lamp T8 linear
1,000W lamp HID	(2) 4-lamp T5HO linear or (2) 6-lamp T8 linear

9.2.3.6 Unit Basis

This measure's incentive, savings, and incremental measure cost are determined on a "per fixture" basis.

9.2.3.7 Effective Useful Life

This measure has an effective useful life of 15 years determined from DEER 2008[58].

9.2.3.8 Incremental Measure Cost

The incremental cost for this measure varies depending on the lamp type and lamp length of the newly installed fixture and includes the total material and labor costs. Incremental costs are derived from contractor interviews and secondary sources. Specific incremental costs for different fixture types can be found in Table 10-6.

9.2.3.9 Annual Energy Savings Algorithm

The following algorithm is used to estimate annual energy saving impacts for this measure. Numeric values for the variables can be found in Table 10-6.

$$\Delta kWh = \frac{(W_{base} - W_{ee})}{1000} \times OpHrs \times (1 + EIF)$$

Where:

ΔkWh	=	Energy savings for measure (in kWh)
W_{base}	=	Baseline Wattage of Fixture
W_{ee}	=	Efficient Wattage of Fixture
OpHrs	=	Hours of Operation
EIF	=	Energy Interaction Factor

9.2.3.10 Coincident Peak Demand Savings Algorithm

The following algorithm is used to estimate annual coincident peak demand saving impacts for this measure. Numeric values for the variables can be found in Table 10-6.

$$\Delta kW_{coincident} = \frac{(W_{base} - W_{ee})}{1000} \times (1 + DIF) \times DF \times CF$$

Where:

$\Delta kW_{coincident}$	=	Coincident peak demand savings for this measure (in kW)
W_{base}	=	Baseline Wattage of Fixture
W_{ee}	=	Efficient Wattage of Fixture
DIF	=	Demand Interaction Factor
DF	=	Diversity Factor
CF	=	Coincidence Factor

[58] http://www.deeresources.com/

9.2.3.11 Algorithm Input Values by Measure

The values presented in the following table are based on historical participation data for the Solutions for Business programs. Values are weighted averages based on the sector-specific values presented in Table 9-1.

Table 9-6. Measure Lookup Values - HID to Linear Fluorescent

Measure Sub-Category	Measure	OpHrs	DIF	EIF	CF	DF	W_{base}	W_{ee}	Incremental Cost ($/fixture)
HID to Linear Fluorescent Retrofit	(2) 4-lamp 4ft T5HO replacing 1000W HPS	3390	0.17	0.15	0.76	0.87	1100	468	$467.37
HID to Linear Fluorescent Retrofit	(2) 4-lamp 4ft T5HO replacing 1000W MH	3390	0.17	0.15	0.76	0.87	1070	468	$467.37
HID to Linear Fluorescent Retrofit	(2) 4-lamp 4ft T5HO replacing 750W HPS	3390	0.17	0.15	0.76	0.87	847.5	468	$467.37
HID to Linear Fluorescent Retrofit	(2) 4-lamp 4ft T5HO replacing 750W MH	3390	0.17	0.15	0.76	0.87	814	468	$467.37
HID to Linear Fluorescent Retrofit	(2) 6-lamp 4ft T8 replacing 1000W HPS	3390	0.17	0.15	0.76	0.87	1100	384	$432.15
HID to Linear Fluorescent Retrofit	(2) 6-lamp 4ft T8 replacing 1000W MH	3390	0.17	0.15	0.76	0.87	1070	384	$432.15
HID to Linear Fluorescent Retrofit	(2) 6-lamp 4ft T8 replacing 750W HPS	3390	0.17	0.15	0.76	0.87	847.5	384	$432.15
HID to Linear Fluorescent Retrofit	(2) 6-lamp 4ft T8 replacing 750W MH	3390	0.17	0.15	0.76	0.87	814	384	$432.15
HID to Linear Fluorescent Retrofit	2-lamp 4ft T5HO replacing 150W HPS	3390	0.17	0.15	0.76	0.87	190	117.5	$195.69
HID to Linear Fluorescent Retrofit	2-lamp 4ft T5HO replacing 150W MH	3390	0.17	0.15	0.76	0.87	185	117.5	$195.69
HID to Linear Fluorescent Retrofit	2-lamp 4ft T5HO replacing 175W HPS	3390	0.17	0.15	0.76	0.87	216.3	117.5	$195.69
HID to Linear Fluorescent Retrofit	2-lamp 4ft T5HO replacing 175W MH	3390	0.17	0.15	0.76	0.87	211.3	117.5	$195.69
HID to Linear Fluorescent Retrofit	2-lamp 4ft T8 replacing 150W HPS	3390	0.17	0.15	0.76	0.87	190	55	$176.07
HID to Linear Fluorescent Retrofit	2-lamp 4ft T8 replacing 150W MH	3390	0.17	0.15	0.76	0.87	185	55	$176.07
HID to Linear Fluorescent Retrofit	2-lamp 4ft T8 replacing 175W HPS	3390	0.17	0.15	0.76	0.87	216.3	55	$176.07
HID to Linear Fluorescent Retrofit	2-lamp 4ft T8 replacing 175W MH	3390	0.17	0.15	0.76	0.87	211.3	55	$176.07
HID to Linear Fluorescent Retrofit	3-lamp 4ft T5HO replacing 250W HPS	3390	0.17	0.15	0.76	0.87	295	179	$223.69
HID to Linear Fluorescent Retrofit	3-lamp 4ft T5HO replacing 250W MH	3390	0.17	0.15	0.76	0.87	290	179	$223.69

HID to Linear Fluorescent Retrofit	3-lamp 4ft T8 replacing 250W HPS	3390	0.17	0.15	0.76	0.87	295	81	$182.07
HID to Linear Fluorescent Retrofit	3-lamp 4ft T8 replacing 250W MH	3390	0.17	0.15	0.76	0.87	290	81	$182.07
HID to Linear Fluorescent Retrofit	4-lamp 2ft T5HO replacing 150W HPS	3390	0.17	0.15	0.76	0.87	190	106	$233.69
HID to Linear Fluorescent Retrofit	4-lamp 2ft T5HO replacing 150W MH	3390	0.17	0.15	0.76	0.87	185	106	$233.69
HID to Linear Fluorescent Retrofit	4-lamp 2ft T8 replacing 150W HPS	3390	0.17	0.15	0.76	0.87	190	61	$233.69
HID to Linear Fluorescent Retrofit	4-lamp 2ft T8 replacing 150W MH	3390	0.17	0.15	0.76	0.87	185	61	$233.69
HID to Linear Fluorescent Retrofit	4-lamp 4ft T5HO replacing 400W HPS	3390	0.17	0.15	0.76	0.87	464	234	$233.69
HID to Linear Fluorescent Retrofit	4-lamp 4ft T5HO replacing 400W MH	3390	0.17	0.15	0.76	0.87	455	234	$233.69
HID to Linear Fluorescent Retrofit	4-lamp 4ft T8 replacing 250W HPS	3390	0.17	0.15	0.76	0.87	295	106.5	$210.07
HID to Linear Fluorescent Retrofit	4-lamp 4ft T8 replacing 250W MH	3390	0.17	0.15	0.76	0.87	290	106.5	$210.07
HID to Linear Fluorescent Retrofit	6-lamp 4ft T5HO replacing 400W HPS	3390	0.17	0.15	0.76	0.87	464	351	$251.33
HID to Linear Fluorescent Retrofit	6-lamp 4ft T5HO replacing 400W MH	3390	0.17	0.15	0.76	0.87	455	351	$251.33
HID to Linear Fluorescent Retrofit	6-lamp 4ft T5HO replacing 750W HPS	3390	0.17	0.15	0.76	0.87	847.5	351	$251.33
HID to Linear Fluorescent Retrofit	6-lamp 4ft T5HO replacing 750W MH	3390	0.17	0.15	0.76	0.87	814	351	$251.33
HID to Linear Fluorescent Retrofit	6-lamp 4ft T8 replacing 400W HPS	3390	0.17	0.15	0.76	0.87	464	192	$216.07
HID to Linear Fluorescent Retrofit	6-lamp 4ft T8 replacing 400W MH	3390	0.17	0.15	0.76	0.87	455	192	$216.07

9.2.4 Induction Lighting

9.2.4.1 Applicability

Retrofit

9.2.4.2 Applicable Programs

This measure is applicable to APS' Solutions for Business programs, which include:

- Large Existing
- New Construction
- Small Business
- Schools

9.2.4.3 Measure Description

This lighting end-use measure promotes the replacement of HID lamps with induction lamps.

9.2.4.4 Baseline Equipment Definition

The baseline case refers to HID lamps that include Metal Halides (MH) and High Pressure Sodium (HPS) lamps with wattages varying from 70 watts up to 400 watts.

9.2.4.5 Efficient Equipment Definition

The efficient case refers to induction lamps with wattages varying from 40 watts up to 165 watts. To ensure that the efficient equipment reduces the connected load, Table 9-7 shows the following baseline-efficient equipment retrofit combinations that are allowed.

Table 9-7. Induction Lighting Retrofit Combination Types

Retrofit Combination Types
Induction Lighting replacing >200W and <=250W MH
Induction Lighting replacing >200W and <=400W HPS
Induction Lighting replacing >=100W and <=200W HPS
Induction Lighting replacing >=70W and <=200W MH

9.2.4.6 Unit Basis

This measure's incentive, savings, and incremental measure cost are determined on a "per fixture" basis.

9.2.4.7 Effective Useful Life

This measure has an effective useful life of 20 years determined from DEER 2008[59].

9.2.4.8 Incremental Measure Cost

The incremental cost for this measure varies depending on the wattages of the replacement induction lighting lamps and includes the total material and labor costs. Incremental costs are derived from contractor interviews and secondary sources. Specific incremental costs for different lamp wattages can be found in Table 9-8.

9.2.4.9 Annual Energy Savings Algorithm

The following algorithm is used to estimate annual energy saving impacts for this measure. Numeric values for the variables can be found in Table 9-8.

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[59] http://www.deeresources.com/

$$\Delta kWh = \frac{(W_{base} - W_{ee})}{1000} \times OpHrs \times (1 + EIF)$$

Where:

ΔkWh	=	Energy savings for measure (in kWh)
W_{base}	=	Baseline Wattage of Fixture
W_{ee}	=	Efficient Wattage of Fixture
OpHrs	=	Hours of Operation
EIF	=	Energy Interaction Factor

9.2.4.10 Coincident Peak Demand Savings Algorithm

The following algorithm is used to estimate annual coincident peak demand saving impacts for this measure. Numeric values for the variables can be found in Table 9-8.

$$\Delta kW_{coincident} = \frac{(W_{base} - W_{ee})}{1000} \times (1 + DIF) \times DF \times CF$$

Where:

$\Delta kW_{coincident}$	=	Coincident peak demand savings for this measure (in kW)
W_{base}	=	Baseline Wattage of Fixture
W_{ee}	=	Efficient Wattage of Fixture
DIF	=	Demand Interaction Factor
DF	=	Diversity Factor
CF	=	Coincidence Factor

9.2.4.11 Algorithm Input Values by Measure

The values presented in the following table are based on historical participation data for the Solutions for Business programs. Values are weighted averages based on the sector-specific values presented in Table 9-1.

Table 9-8. Measure Lookup Values - Induction Lighting

Measure Sub-Category	Measure	OpHrs	DIF	EIF	CF	DF	W_{base}	W_{ee}	Incremental Cost ($/fixture)
Induction Lighting	Induction Lighting replacing >200W and <=250W MH	2663	0.16	0.14	0.61	0.82	295	160.9	$204.00
Induction Lighting	Induction Lighting replacing >200W and <=400W HPS	2663	0.16	0.14	0.61	0.82	379	127.7	$272.00
Induction Lighting	Induction Lighting replacing >=100W and <=200W HPS	263	0.16	0.14	0.61	0.82	188	63.8	$254.00
Induction Lighting	Induction Lighting replacing >=70W and <=200W MH	2663	0.16	0.14	0.61	0.82	163.2	76.1	$152.00

9.2.5 Screw-in CFL

9.2.5.1 Applicability

Retrofit

9.2.5.2 Applicable Programs

This measure is applicable to APS' Solutions for Business programs, which include:

- Large Existing
- New Construction
- Small Business
- Schools

9.2.5.3 Measure Description

This lighting end-use measure promotes the replacement of incandescent lamps with screw-in compact fluorescent lamps (CFLs).

9.2.5.4 Baseline Equipment Definition

The baseline case refers to incandescent lamps with wattages varying from 40 watts up to 90 watts assigned to different CFL wattages.

9.2.5.5 Efficient Equipment Definition

The efficient case refers to screw-in CFLs with wattages varying from 7 watts up to 27 watts.

9.2.5.6 Unit Basis

This measure's incentive, savings, and incremental measure cost are determined on a "per lamp" basis.

9.2.5.7 Effective Useful Life

This measure has an effective useful life of 2 years determined from estimated CFL lifetime and from annual hours of operation.

9.2.5.8 Incremental Measure Cost

The incremental cost for this measure varies depending on the wattages of the CFLs and includes the total material and labor costs. Incremental costs are derived from contractor interviews and secondary sources. Specific incremental costs for different lamp wattages can be found in Table 9-9.

9.2.5.9 Annual Energy Savings Algorithm

The following algorithm is used to estimate annual energy saving impacts for this measure. Numeric values for the variables can be found in Table 9-9.

$$\Delta kWh = \frac{(W_{base} - W_{ee})}{1000} \times OpHrs \times (1 + EIF)$$

Where:

ΔkWh	=	Energy savings for measure (in kWh)
W_{base}	=	Baseline Wattage of Lamp
W_{ee}	=	Efficient Wattage of Lamp
OpHrs	=	Hours of Operation
EIF	=	Energy Interaction Factor

9.2.5.10 Coincident Peak Demand Savings Algorithm

The following algorithm is used to estimate annual coincident peak demand saving impacts for this measure. Numeric values for the variables can be found in Table 9-9.

$$\Delta kW_{coincident} = \frac{(W_{base} - W_{ee})}{1000} \times (1 + DIF) \times DF \times CF$$

Where:

$\Delta kW_{coincident}$	=	Coincident peak demand savings for this measure (in kW)
W_{base}	=	Baseline Wattage of Lamp
W_{ee}	=	Efficient Wattage of Lamp
DIF	=	Demand Interaction Factor
DF	=	Diversity Factor
CF	=	Coincidence Factor

9.2.5.11 Algorithm Input Values by Measure

The values presented in the following table are based on historical participation data for the Solutions for Business programs. Values are weighted averages based on the sector-specific values presented in Table 9-1.

Table 9-9. Measure Lookup Values - Screw-In CFL

Measure Sub-Category	Measure	OpHrs	DIF	EIF	CF	DF	W_{base}	W_{ee}	Incremental Cost ($/lamp)
Screw-In CFL	Compact fluorescent Lamps 14 w Screw-In	3517	0.19	0.16	0.65	0.78	60	14	$4.25
Screw-In CFL	Compact fluorescent Lamps 15 w Screw-In	3517	0.19	0.16	0.65	0.78	60	15	$4.52
Screw-In CFL	Compact fluorescent Lamps 18 w Screw-In	3517	0.19	0.16	0.65	0.78	75	18	$5.32
Screw-In CFL	Compact fluorescent Lamps 20 w Screw-In	3517	0.19	0.16	0.65	0.78	75	20	$5.86
Screw-In CFL	Compact fluorescent Lamps 23 w Screw-In	3517	0.19	0.16	0.65	0.78	90	23	$6.66
Screw-In CFL	Compact fluorescent Lamps 26 w Screw-In	3517	0.19	0.16	0.65	0.78	90	26	$7.46
Screw-In CFL	Compact fluorescent Lamps 27 w Screw-In	3517	0.19	0.16	0.65	0.78	90	27	$7.72
Screw-In CFL	Compact fluorescent Lamps 7 w Screw-In	3517	0.19	0.16	0.65	0.78	40	7	$2.39

9.2.6 Hardwired CFL

9.2.6.1 Applicability

Retrofit

9.2.6.2 Applicable Programs

This measure is applicable to APS' Solutions for Business programs, which include:

» Large Existing
» New Construction
» Small Business
» Schools

9.2.6.3 Measure Description

This lighting end-use measure promotes the replacement of incandescent lamps and fixtures with hardwired CFLs and fixtures.

9.2.6.4 Baseline Equipment Definition

The baseline case refers to incandescent fixtures with wattages varying from 40 watts up to 300 watts assigned to different CFL wattages.

9.2.6.5 Efficient Equipment Definition

The efficient case refers to hardwired CFL fixtures with wattages varying from 7 watts up to 84 watts.

9.2.6.6 Unit Basis

This measure's incentive, savings, and incremental measure cost are determined on a "per fixture" basis.

9.2.6.7 Effective Useful Life

This measure has an effective useful life of 12 years determined from estimated CFL lifetime and from annual hours of operation.

9.2.6.8 Incremental Measure Cost

The incremental cost for this measure varies depending on the wattages of the CFLs and includes the total material and labor costs. Incremental costs are derived from contractor interviews and secondary sources. Specific incremental costs for different lamp wattages can be found in Table 9-10.

9.2.6.9 Annual Energy Savings Algorithm

The following algorithm is used to estimate annual energy saving impacts for this measure. Numeric values for the variables can be found in Table 9-10.

$$\Delta kWh = \frac{(W_{base} - W_{ee})}{1000} \times OpHrs \times (1 + EIF)$$

Where:

ΔkWh	=	Energy savings for measure (in kWh)
W_{base}	=	Baseline Wattage of Fixture
W_{ee}	=	Efficient Wattage of Fixture
OpHrs	=	Hours of Operation
EIF	=	Energy Interaction Factor

9.2.6.10 Coincident Peak Demand Savings Algorithm

The following algorithm is used to estimate annual coincident peak demand saving impacts for this measure. Numeric values for the variables can be found in Table 9-10.

$$\Delta kW_{coincident} = \frac{(W_{base} - W_{ee})}{1000} \times (1 + DIF) \times DF \times CF$$

Where:

$\Delta kW_{coincident}$	=	Coincident peak demand savings for this measure (in kW)
W_{base}	=	Baseline Wattage of Fixture
W_{ee}	=	Efficient Wattage of Fixture
DIF	=	Demand Interaction Factor
DF	=	Diversity Factor
CF	=	Coincidence Factor

9.2.6.11 Algorithm Input Values by Measure

The values presented in the following table are based on historical participation data for the Solutions for Business programs. Values are weighted averages based on the sector-specific values presented in Table 9-1.

Table 9-10. Measure Lookup Values - Hardwired CFL

Measure Sub-Category	Measure	OpHrs	DIF	EIF	CF	DF	W_{base}	W_{ee}	Incremental Cost ($/fixture)
Hardwired CFL	Compact fluorescent Lamps 13 w Hardwired	4086	0.18	0.15	0.82	0.87	60	13	$95.65
Hardwired CFL	Compact fluorescent Lamps 14 w Hardwired	4086	0.18	0.15	0.82	0.87	60	14	$95.65
Hardwired CFL	Compact fluorescent Lamps 18 w Hardwired	4086	0.18	0.15	0.82	0.87	64	18	$95.65
Hardwired CFL	Compact fluorescent Lamps 23 w Hardwired	4086	0.18	0.15	0.82	0.87	80	23	$95.65
Hardwired CFL	Compact fluorescent Lamps 26 w Hardwired	4086	0.18	0.15	0.82	0.87	80	26	$95.65
Hardwired CFL	Compact fluorescent Lamps 27 w Hardwired	4086	0.18	0.15	0.82	0.87	80	27	$95.65
Hardwired CFL	Compact fluorescent Lamps 32 w Hardwired	4086	0.18	0.15	0.82	0.87	150	32	$132.39
Hardwired CFL	Compact fluorescent Lamps 7 w Hardwired	4086	0.18	0.15	0.82	0.87	40	7	$95.65
Hardwired CFL	Compact fluorescent Lamps 84 w Hardwired	4086	0.18	0.15	0.82	0.87	300	84	$132.39

9.2.7 Exit Signs

9.2.7.1 Applicability

Retrofit

9.2.7.2 Applicable Programs

This measure is applicable to APS' Solutions for Business programs, which include:

» Large Existing
» New Construction
» Small Business
» Schools

9.2.7.3 Measure Description

This lighting end-use measure promotes the replacement of exit signs with incandescent or CFL bulbs with more efficient exit signs with light-emitting diode (LED) or electroluminescent bulbs. This measure applies to both single and double face exit signs.

9.2.7.4 Baseline Equipment Definition

The baseline case refers to exit signs with incandescent or CFL lamps.

9.2.7.5 Efficient Equipment Definition

The efficient case refers to exits signs with LED or electroluminescent bulbs.

9.2.7.6 Unit Basis

This measure's incentive, savings, and incremental measure cost are determined on a "per exit sign" basis.

9.2.7.7 Effective Useful Life

This measure has an effective useful life of 16 years determined from DEER 2008[60].

9.2.7.8 Incremental Measure Cost

The incremental cost for this measure varies depending on the type of efficient exit sign being installed and includes the total material and labor costs. Incremental costs are derived from contractor interviews and secondary sources. Specific incremental costs for different exit signs can be found in Table 9-11.

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[60] http://www.deeresources.com/

9.2.7.9 Annual Energy Savings Algorithm

The following algorithm is used to estimate annual energy saving impacts for this measure. Numeric values for the variables can be found in Table 9-11.

$$\Delta kWh = \frac{(W_{base} - W_{ee})}{1000} \times OpHrs \times (1 + EIF)$$

Where:

ΔkWh	=	Energy savings for measure (in kWh)
W_{base}	=	Baseline Wattage of Exit Sign
W_{ee}	=	Efficient Wattage of Sign
OpHrs	=	Hours of Operation
EIF	=	Energy Interaction Factor

9.2.7.10 Coincident Peak Demand Savings Algorithm

The following algorithm is used to estimate annual coincident peak demand saving impacts for this measure. Numeric values for the variables can be found in Table 9-11.

$$\Delta kW_{Coincident} = \frac{(W_{base} - W_{ee})}{1000} \times (1 + DIF) \times DF \times CF$$

Where:

$\Delta kW_{coincident}$	=	Coincident peak demand savings for this measure (in kW)
W_{base}	=	Baseline Wattage of Exit Sign
W_{ee}	=	Efficient Wattage of Exit Sign
DIF	=	Demand Interaction Factor
DF	=	Diversity Factor
CF	=	Coincidence Factor

9.2.7.11 Algorithm Input Values by Measure

The values presented in the following table are based on historical participation data for the Solutions for Business programs. Values are weighted averages based on the sector-specific values presented in Table 9-1.

Table 9-11. Measure Lookup Values - Exit Sign

Measure Sub-Category	Measure	OpHrs	DIF	EIF	CF	DF	W_{base}	W_{ee}	Incremental Cost ($/exit sign)
Exit Sign Retrofit	Exit Signs (Electroluminescent replacing incandescent)	8760	0.18	0.15	1.00	1.00	29.8	1.5	$78.99
Exit Sign Retrofit	Exit Signs (Electroluminescent replacing CFLs)	8760	0.18	0.15	1.00	1.00	17.5	1.5	$78.99
Exit Sign Retrofit	Exit Signs (LED replacing CFL)	8760	0.18	0.15	1.00	1.00	17.5	5	$58.76
Exit Sign Retrofit	Exit Signs (LED replacing incandescent)	8760	0.18	0.15	1.00	1.00	29.8	5	$58.76

9.2.8 Occupancy Sensors

9.2.8.1 Applicability

Retrofit and New Construction

Refer to Section 9.2.8.4for further details.

9.2.8.2 Applicable Programs

This measure is applicable to APS' Solutions for Business programs, which include:

- Large Existing
- New Construction
- Small Business
- Schools

9.2.8.3 Measure Description

This lighting end-use measure promotes the installation of wall box or ceiling mounted occupancy-based controls on interior lighting equipment (RET) or new lighting equipment (NC).

9.2.8.4 Baseline Equipment Definition

The baseline case refers to interior lighting equipment without occupancy sensor controls.

9.2.8.5 Efficient Equipment Definition

The efficient case refers to interior lighting equipment with occupancy sensor controls.

NAVIGANT

9.2.8.6 Unit Basis

This measure's incentive and incremental measure cost are based on a "per connected watts" basis, whereas the measure's savings are determined on a "per sensor" basis.

9.2.8.7 Effective Useful Life

This measure has an effective useful life of 8 years determined from DEER 2008[61].

9.2.8.8 Incremental Measure Cost

The incremental cost for this measure varies depending on the type of efficient exit sign being installed and includes the total material and labor costs. Incremental costs are derived from contractor interviews and secondary sources. Specific incremental costs for different lamp wattages can be found in Table 9-12.

9.2.8.9 Annual Energy Savings Algorithm

The following algorithm is used to estimate annual energy saving impacts for this measure. Numeric values for the variables can be found in Table 9-12.

$$\Delta kWh = \frac{W_{CL} \times OpHrs}{1000} \times (1 + EIF) \times ESF$$

Where:

ΔkWh	=	Energy savings for measure (in kWh)
W_{CL}	=	Connected Load of Lighting Equipment
OpHrs	=	Hours of Operation
EIF	=	Energy Interaction Factor
ESF	=	Energy Savings Factor

[61] http://www.deeresources.com/

9.2.8.10 Coincident Peak Demand Savings Algorithm

The following algorithm is used to estimate annual coincident peak demand saving impacts for this measure. Numeric values for the variables can be found in Table 9-12.

$$\Delta kW_{coincident} = \frac{W_{CL}}{1000} \times (1 + DIF) \times CF \times DF \times DSF$$

Where:

$\Delta kW_{coincident}$	=	Coincident peak demand savings for this measure (in kW)
W_{CL}	=	Connected Load of Lighting Equipment
DIF	=	Demand Interaction Factor
CF	=	Coincidence Factor
DF	=	Diversity Factor
DSF	=	Demand Savings Factor

9.2.8.11 Algorithm Input Values by Measure

The values presented in the following table are based on historical participation data for the Solutions for Business programs. Values are weighted averages based on the sector-specific values presented in Table 9-1.

Table 9-12. Measure Lookup Values - Occupancy Sensor

Measure Sub-Category	Measure	OpHrs	DIF	EIF	CF	DF	ESF	DSF	Incremental Cost ($/connected watt)
Occupancy Sensors	Occupancy Sensors	2612	0.12	0.12	0.59	0.81	0.39	0.16	$0.29

9.2.9 Daylighting Controls

9.2.9.1 Applicability

Retrofit and New Construction

Refer to Section 9.2.9.4 for further details.

9.2.9.2 Applicable Programs

This measure is applicable to APS' Solutions for Business programs, which include:

» Large Existing
» New Construction
» Small Business
» Schools

9.2.9.3 Measure Description

This lighting end-use measure promotes the installation of photo sensors that control dimming ballasts or dimming systems on interior lighting equipment (RET) or new lighting equipment (NC).

9.2.9.4 Baseline Equipment Definition

The baseline case refers to interior lighting equipment without photo sensors.

9.2.9.5 Efficient Equipment Definition

The efficient case refers to interior lighting equipment without photo sensors.

9.2.9.6 Unit Basis

This measure's incentive, savings, and incremental measure cost are determined on a "per connected watts" basis.

9.2.9.7 Effective Useful Life

This measure has an effective useful life of 15 years determined from DEER 2008[62].

9.2.9.8 Incremental Measure Cost

The incremental cost for this measure varies depending on the type of efficient exit sign being installed and includes the total material and labor costs. Incremental costs are derived from contractor interviews and secondary sources. Specific incremental costs for different lamp wattages can be found in Table 9-13.

9.2.9.9 Annual Energy Savings Algorithm

The following algorithm is used to estimate annual energy saving impacts for this measure. Numeric values for the variables can be found in Table 9-13.

[62] http://www.deeresources.com/

$$\Delta kWh = \frac{W_{CL} \times OpHrs}{1000} \times (1 + EIF) \times ESF$$

Where:

ΔkWh	=	Energy savings for measure (in kWh)
W_{CL}	=	Connected Load of Lighting Equipment
OpHrs	=	Hours of Operation
EIF	=	Energy Interaction Factor
ESF	=	Energy Savings Factor

9.2.9.10 Coincident Peak Demand Savings Algorithm

The following algorithm is used to estimate annual coincident peak demand saving impacts for this measure. Numeric values for the variables can be found in Table 9-13.

$$\Delta kW_{Coincident} = \frac{W_{CL}}{1000} \times (1 + DIF) \times CF \times DF \times DSF$$

Where:

$\Delta kW_{coincident}$	=	Coincident peak demand savings for this measure (in kW)
W_{CL}	=	Connected Load of Lighting Equipment
DIF	=	Demand Interaction Factor
CF	=	Coincidence Factor
DF	=	Diversity Factor
DSF	=	Demand Savings Factor

9.2.9.11 Algorithm Input Values by Measure

The values presented in the following table are based on historical participation data for the Solutions for Business programs. Values are weighted averages based on the sector-specific values presented in Table 9-1.

Table 9-13. Measure Lookup Values - Daylighting Controls

Measure Sub-Category	Measure	OpHrs	DIF	EIF	CF	DF	ESF	DSF	Incremental Cost ($/connected watts)
Daylighting Controls	Daylighting Controls	4516	0.19	0.16	0.87	0.88	0.54	0.54	$0.75

9.2.10 T12/T8 Delamping

9.2.10.1 Applicability

Retrofit

9.2.10.2 Applicable Programs

This measure is applicable to APS' Solutions for Business programs, which include:

» Large Existing
» New Construction
» Small Business
» Schools

9.2.10.3 Measure Description

This lighting end-use measure promotes the permanent removal of fluorescent lamps in existing fixtures. Lighting retrofits are part of the measure found in Section 9.2

9.2.10.4 Baseline Equipment Definition

The baseline case refers to an existing T12 fixture or a T8 fixture that has not been retrofitted or delamped.

9.2.10.5 Efficient Equipment Definition

The efficient case refers to a T12 fixture or a T8 fixture that has been delamped. A reflector may be added when delamping to maintain adequate lighting levels.

9.2.10.6 Unit Basis

This measure's incentive and incremental measure cost are determined on a "per lamp" basis, whereas the measure's savings are determined on a "per fixture" basis.

9.2.10.7 Effective Useful Life

This measure has an effective useful life of 15 years determined from DEER 2008[63].

9.2.10.8 Incremental Measure Cost

The incremental cost for this measure varies depending on the number of lamps per fixture being delamped and includes the total material and labor costs. Incremental costs are derived from contractor interviews and secondary sources. Specific incremental costs can be found in Table 9-14.

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[63] http://www.deeresources.com/

9.2.10.9 Annual Energy Savings Algorithm

The following algorithm is used to estimate annual energy saving impacts for this measure. Numeric values for the variables can be found in Table 9-14.

$$\Delta kWh = \frac{(W_{base} - W_{ee})}{1000} \times OpHrs \times (1 + EIF)$$

Where:

ΔkWh	=	Energy savings for measure (in kWh)
W_{base}	=	Baseline Wattage of Fixture
W_{ee}	=	Efficient Wattage of Fixture
OpHrs	=	Hours of Operation
EIF	=	Energy Interaction Factor

9.2.10.10 Coincident Peak Demand Savings Algorithm

The following algorithm is used to estimate annual coincident peak demand saving impacts for this measure. Numeric values for the variables can be found in Table 9-14.

$$\Delta kW_{coincident} = \frac{(W_{base} - W_{ee})}{1000} \times (1 + DIF) \times DF \times CF$$

Where:

$\Delta kW_{coincident}$	=	Coincident peak demand savings for this measure (in kW)
W_{base}	=	Baseline Wattage of Fixture
W_{ee}	=	Efficient Wattage of Fixture
DIF	=	Demand Interaction Factor
DF	=	Diversity Factor
CF	=	Coincidence Factor

9.2.10.11 Algorithm Input Values by Measure

The values presented in the following table are based on historical participation data for the Solutions for Business programs. Values are weighted averages based on the sector-specific values presented in Table 9-1.

Table 9-14. Measure Lookup Values - Delamping

Measure Sub-Category	Measure	OpHrs	DIF	EIF	CF	DF	W_{base}	W_{ee}	Incremental Cost ($/lamp)
T12/T8 Delamping	2-foot lamp	2931	0.16	0.14	0.68	0.81	42.8	28.9	$13.61
T12/T8 Delamping	3-foot lamp	2931	0.16	0.14	0.68	0.81	61.6	41.4	$13.61
T12/T8 Delamping	4-foot lamp	2931	0.16	0.14	0.68	0.81	76.1	49.6	$13.62
T12/T8 Delamping	8-foot lamp	2931	0.16	0.14	0.68	0.81	102.0	76.5	$14.03

9.2.11 Cold Cathode Fluorescent Lighting

9.2.11.1 Applicability

Retrofit

9.2.11.2 Applicable Programs

This measure is applicable to APS' Solutions for Business programs, which include:

» Large Existing
» New Construction
» Small Business
» Schools

9.2.11.3 Measure Description

This lighting end-use measure promotes the replacement of incandescent lamps and fixtures with cold cathode fluorescent CFLs.

9.2.11.4 Baseline Equipment Definition

The baseline case refers to incandescent fixtures with wattages varying from 25 watts up to 58 watts assigned to different cold cathode CFL wattages.

9.2.11.5 Efficient Equipment Definition

The efficient case refers to cold cathode CFL fixtures with wattages varying from 3 watts up to 8 watts.

9.2.11.6 Unit Basis

This measure's incentive, savings, and incremental measure cost are determined on a "per fixture" basis.

9.2.11.7 Effective Useful Life

This measure has an effective useful life of 4 years determined from estimated fluorescent fixture lifetime and from annual hours of operation.

9.2.11.8 Incremental Measure Cost

The incremental cost for this measure varies depending on the wattages of the CFLs and includes the total material and labor costs. Incremental costs are derived from contractor interviews and secondary sources. Specific incremental costs for different lamp wattages can be found in Table 9-15.

9.2.11.9 Annual Energy Savings Algorithm

The following algorithm is used to estimate annual energy saving impacts for this measure. Numeric values for the variables can be found in Table 9-15.

$$\Delta kWh = \frac{(W_{base} - W_{ee})}{1000} \times OpHrs \times (1 + EIF)$$

Where:

ΔkWh	=	Energy savings for measure (in kWh)
W_{base}	=	Baseline Wattage of Fixture
W_{ee}	=	Efficient Wattage of Fixture
OpHrs	=	Hours of Operation
EIF	=	Energy Interaction Factor

9.2.11.10 Coincident Peak Demand Savings Algorithm

The following algorithm is used to estimate annual coincident peak demand saving impacts for this measure. Numeric values for the variables can be found in Table 9-15.

$$\Delta kW_{coincident} = \frac{(W_{base} - W_{ee})}{1000} \times (1 + DIF) \times DF \times CF$$

Where:

$\Delta kW_{coincident}$	=	Coincident peak demand savings for this measure (in kW)
W_{base}	=	Baseline Wattage of Fixture
W_{ee}	=	Efficient Wattage of Fixture
DIF	=	Demand Interaction Factor
DF	=	Diversity Factor
CF	=	Coincidence Factor

9.2.11.11 Algorithm Input Values by Measure

The values presented in the following table are based on historical participation data for the Solutions for Business programs. Values are weighted averages based on the sector-specific values presented in Table 9-1.

Table 9-15. Measure Lookup Values - Cold Cathode

Measure Sub-Category	Measure	OpHrs	DIF	EIF	CF	DF	W_{base}	W_{ee}	Incremental Cost ($/fixture)
Cold Cathode Fluorescent Lighting	Cold Cathode Fluorescent Lamps 3 w	6400	0.20	0.17	1.00	1.00	25	3	$13.36
Cold Cathode Fluorescent Lighting	Cold Cathode Fluorescent Lamps 5 w	6400	0.20	0.17	1.00	1.00	35	5	$11.72
Cold Cathode Fluorescent Lighting	Cold Cathode Fluorescent Lamps 8 w	6400	0.20	0.17	1.00	1.00	58	8	$21.12

9.2.12 Reduced Lighting Power Density

9.2.12.1 Applicability

New Construction

9.2.12.2 Applicable Programs

This measure is applicable to APS' Solutions for Business programs, which include:

» New Construction

9.2.12.3 Measure Description

This lighting end-use measure promotes the installation of efficient lighting with lighting power density (LPD) in watts per square foot (W/SF) less than or equal to values listed in ASHRAE 90.1-2004 corresponding to different building types.

9.2.12.4 Baseline Equipment Definition

The baseline case refers to the LPD in W/SF by building type as listed in ASHRAE 90.1-2004.

9.2.12.5 Efficient Equipment Definition

The efficient case refers to the calculated LPD in W/SF based on total connected lighting load within a particular space area.

NAVIGANT

9.2.12.6 Unit Basis

This measure's incentive, savings, and incremental measure cost are determined on a "per watt reduced" basis.

9.2.12.7 Effective Useful Life

This measure has an effective useful life of 12 years determined from DEER 2008[64].

9.2.12.8 Incremental Measure Cost

The incremental cost for this measure is the same for all building types besides parking garage and includes the total material and labor costs. Incremental costs are derived from contractor interviews and secondary sources. Specific incremental costs for different lamp wattages can be found in Table 9-16.

9.2.12.9 Annual Energy Savings Algorithm

The following algorithm is used to estimate annual energy saving impacts for this measure. Numeric values for the variables can be found in Table 9-16.

$$\Delta kWh = \frac{(LPD_{base} - LPD_{ee})}{1000} \times Area \times OpHrs \times (1 + EIF)$$

Where:

ΔkWh	=	Energy savings for measure (in kWh)
LPD_{base}	=	LPD of building type as specified by ASHRAE 90.1-2004 (in W/SF)
LPD_{ee}	=	LPD of calculated Space Area (in W/SF)
Area	=	Space Area of lighted area (in SF)
OpHrs	=	Hours of Operation
EIF	=	Energy Interaction Factor

9.2.12.10 Coincident Peak Demand Savings Algorithm

The following algorithm is used to estimate annual coincident peak demand saving impacts for this measure. Numeric values for the variables can be found in Table 9-16.

$$\Delta kW_{SummerPeak} = \frac{(LPD_{base} - LPD_{ee})}{1000} \times Area \times (1 + DIF) \times DSF \times CF$$

Where:

64 http://www.deeresources.com/

$\Delta kW_{coincident}$	=	Coincident peak demand savings for this measure (in kW)
LPD_{base}	=	LPD of building type as specified by ASHRAE 90.1-2004 (in W/SF)
LPD_{ee}	=	LPD of calculated Space Area (in W/SF)
Area	=	Space Area of lighted area (in SF)
EIF	=	Energy Interaction Factor
DIF	=	Demand Interaction Factor
DF	=	Diversity Factor
CF	=	Coincidence Factor

9.2.12.11 Algorithm Input Values by Measure

The values presented in the following table are based on historical participation data for the Solutions for Business programs. Values are weighted averages based on the sector-specific values presented in Table 9-1.

Table 9-16. Measure Lookup Values - Reduced Lighting Power Density

Measure Sub-Category	Measure	OpHrs	DIF	EIF	CF	DF	LPD_{base}	Incremental Cost ($/watt reduced)
Lighting Power Density	Automotive Facility	2769	0.20	0.17	0.65	0.89	0.9	$0.87
Lighting Power Density	Convention Center	2769	0.20	0.17	0.65	0.89	1.2	$0.87
Lighting Power Density	Court House	1804	0.20	0.17	0.74	0.66	1.2	$0.87
Lighting Power Density	Dining: Bar Lounge/Leisure	5217	0.20	0.17	0.95	0.90	1.3	$0.87
Lighting Power Density	Dining: Cafeteria/Fast Food	5217	0.20	0.17	0.95	0.90	1.4	$0.87
Lighting Power Density	Dining: Family	5217	0.20	0.17	0.95	0.90	1.6	$0.87
Lighting Power Density	Dormitory	3981	0.20	0.17	0.93	0.90	1	$0.87

Lighting Power Density	Exercise Center	2769	0.20	0.17	0.65	0.89	1	$0.87
Lighting Power Density	Gymnasium	2769	0.20	0.17	0.65	0.89	1.1	$0.87
Lighting Power Density	Health Care Clinic	6739	0.20	0.17	1.00	0.90	1	$0.87
Lighting Power Density	Hospital	6739	0.20	0.17	1.00	0.90	1.2	$0.87
Lighting Power Density	Hotel	3108	0.20	0.17	0.77	0.66	1	$0.87
Lighting Power Density	Library	2769	0.20	0.17	0.65	0.89	1.3	$0.87
Lighting Power Density	Manufacturing Facility	4481	0.20	0.17	0.93	0.90	1.3	$0.87
Lighting Power Density	Motel	3108	0.20	0.17	0.77	0.66	1	$0.87
Lighting Power Density	Motion Picture Theater	2769	0.20	0.17	0.65	0.89	1.2	$0.87
Lighting Power Density	Museum	2769	0.20	0.17	0.65	0.89	1.1	$0.87
Lighting Power Density	Office	1804	0.20	0.17	0.74	0.91	1	$0.87
Lighting Power Density	Parking Garage	2769	0.20	0.17	0.65	0.89	0.3	$0.55
Lighting Power Density	Performing Arts Theater	8002	0.20	0.17	0.65	0.89	1.6	$0.87
Lighting Power Density	Police/Fire Station	1804	0.20	0.17	0.74	0.66	1	$0.87

Lighting Power Density	Post Office	1804	0.20	0.17	0.74	0.66	1.1	$0.87
Lighting Power Density	Religious Building	2769	0.20	0.17	0.65	0.89	1.3	$0.87
Lighting Power Density	Retail (Other Than Mall)	4431	0.20	0.17	0.96	0.92	1.5	$0.87
Lighting Power Density	School/University	1835	0.02	0.04	0.20	0.8	1.2	$0.87
Lighting Power Density	Sports Arena	2769	0.20	0.17	0.65	0.89	1.1	$0.87
Lighting Power Density	Town Hall	2516	0.20	0.17	0.74	0.91	1.1	$0.87
Lighting Power Density	Transportation	2769	0.20	0.17	0.65	0.89	1	$0.87
Lighting Power Density	Warehouse	3432	0.20	0.17	0.90	0.90	0.8	$0.87
Lighting Power Density	Workshop	2769	0.20	0.17	0.65	0.89	1.4	$0.87

9.2.13 Traffic Signals

9.2.13.1 Applicability

Retrofit

9.2.13.2 Applicable Programs

This measure is applicable to APS' Solutions for Business programs, which include:

» Large Existing
» New Construction
» Small Business
» Schools

9.2.13.3 Measure Description

This lighting end-use measure promotes the replacement of existing incandescent traffic lamps with LED lamps for red and green traffic signal lights.

9.2.13.4 Baseline Equipment Definition

The baseline case refers to incandescent traffic lamps for red and green traffic signal lights.

9.2.13.5 Efficient Equipment Definition

The efficient case refers to LED traffic lamps for red and green traffic signal lights varying in voltage, varying both in electronics (12 Volts DC or 120 Volts AC) and diameter (8" or 12").

9.2.13.6 Unit Basis

This measure's incentive, savings, and incremental measure cost are determined on a "per lamp" basis.

9.2.13.7 Effective Useful Life

This measure has an effective useful life of 10 years estimated from various reports.

9.2.13.8 Incremental Measure Cost

The incremental cost for this measure varies depending on the color, electronics, and diameter of the installed LED traffic lamps and includes the total material and labor costs. Incremental costs are derived from contractor interviews and secondary sources. Specific incremental costs of different LED traffic lamps can be found in Table 9-17.

9.2.13.9 Annual Energy Savings Algorithm

The following algorithm is used to estimate annual energy saving impacts for this measure. Numeric values for the variables can be found in Table 9-17.

$$\Delta kWh = \frac{(W_{base} - W_{ee})}{1000} \times OpHrs$$

Where:

ΔkWh	=	Energy savings for measure (in kWh)
W_{base}	=	Baseline Wattage of Lamp
W_{ee}	=	Efficient Wattage of Lamp
OpHrs	=	Hours of Operation

9.2.13.10 Coincident Peak Demand Savings Algorithm

The following algorithm is used to estimate annual coincident peak demand saving impacts for this measure. Numeric values for the variables can be found in Table 9-17.

$$\Delta kW_{coincident} = \frac{(W_{base} - W_{ee})}{1000} \times DF \times CF$$

Where:

$\Delta kW_{coincident}$	=	Coincident peak demand savings for this measure (in kW)
W_{base}	=	Baseline Wattage of Lamp
W_{ee}	=	Efficient Wattage of Lamp
DF	=	Diversity Factor
CF	=	Coincidence Factor

9.2.13.11 Algorithm Input Values by Measure

The values presented in the following table are based on historical participation data for the Solutions for Business programs. Values are weighted averages based on the sector-specific values presented in Table 9-1.

Table 9-17. Measure Lookup Values – LED Traffic Signals

Measure Sub-Category	Measure	OpHrs	CF	DF	W_{base}	W_{ee}	Incremental Cost ($/lamp)
Traffic Signals	LED traffic lights - Green 12" - 120V	3679	1.00	0.42	126	12.9	$113.96
Traffic Signals	LED traffic lights - Green 12" - 12V	3679	1.00	0.42	126	8.1	$99.96
Traffic Signals	LED traffic lights - Green 8" - 120V	3679	1.00	0.42	75	9.1	$69.76
Traffic Signals	LED traffic lights - Green 8" - 12V	3679	1.00	0.42	75	5	$58.36
Traffic Signals	LED traffic lights - Red 12" - 120V	4818	1.00	0.55	126	7.5	$57.16
Traffic Signals	LED traffic lights - Red 12" - 12V	4818	1.00	0.55	126	5.2	$50.36
Traffic Signals	LED traffic lights - Red 8" - 120V	4818	1.00	0.55	75	8.8	$57.76
Traffic Signals	LED traffic lights - Red 8" - 12V	4818	1.00	0.55	75	3	$35.96

9.2.14 LED Channel Lights

9.2.14.1 Applicability

Retrofit

9.2.14.2 Applicable Programs

This measure is applicable to APS' Solutions for Business programs, which include:

- » Large Existing
- » New Construction
- » Small Business
- » Schools

9.2.14.3 Measure Description

This lighting end-use measure promotes the replacement of existing neon channel letter signs with LED channel letter signs.

9.2.14.4 Baseline Equipment Definition

The baseline case refers to neon channel letter signs.

9.2.14.5 Efficient Equipment Definition

The efficient case refers to LED channel letter signs.

9.2.14.6 Unit Basis

This measure's incentive, savings, and incremental measure cost are determined on a "per linear foot of neon signage" basis.

9.2.14.7 Effective Useful Life

This measure has an effective useful life of 10 years determined from estimated LED lifetime and from annual hours of operation.

9.2.14.8 Incremental Measure Cost

The incremental cost for this measure only includes total material cost. Incremental costs are derived from contractor interviews and secondary sources. Specific incremental costs can be found in Table 9-18.

9.2.14.9 Annual Energy Savings Algorithm

The following algorithm is used to estimate annual energy saving impacts for this measure. Numeric values for the variables can be found in Table 9-18.

$$\Delta kWh = \frac{(W_{base} - W_{ee})}{1000} \times OpHrs$$

Where:

ΔkWh	=	Energy savings for measure (in kWh/ linear foot)
W_{base}	=	Baseline Wattage of Lamp
W_{ee}	=	Efficient Wattage of Lamp
OpHrs	=	Hours of Operation

9.2.14.10 Coincident Peak Demand Savings Algorithm

The following algorithm is used to estimate annual coincident peak demand saving impacts for this measure. Numeric values for the variables can be found in Table 9-18.

$$\Delta kW_{coincident} = \frac{(W_{base} - W_{ee})}{1000} \times DF \times CF$$

Where:

$\Delta kW_{coincident}$	=	Coincident peak demand savings for this measure (in kW/ linear foot)
W_{base}	=	Baseline Wattage of Lamp
W_{ee}	=	Efficient Wattage of Lamp
DF	=	Diversity Factor
CF	=	Coincidence Factor

9.2.14.11 Algorithm Input Values by Measure

The values presented in the following table are based on historical participation data for the Solutions for Business programs. Values are weighted averages based on the sector-specific values presented in Table 9-1.

Table 9-18. Measure Lookup Values - LED Channel Lights

Measure Sub-Category	Measure	OpHrs	CF	DF	W_{base}	W_{ee}	Incremental Cost ($/LF)
LED Channel Lights	LED Channel Lights	5110	0.13	1.00	6	1.2	$10.10

9.2.15 LED Lighting (Pedestrian Signals)

9.2.15.1 Applicability

Retrofit

9.2.15.2 Applicable Programs

This measure is applicable to APS' Solutions for Business programs, which include:

- Large Existing
- New Construction
- Small Business
- Schools

9.2.15.3 Measure Description

This lighting end-use measure promotes the replacement of existing incandescent traffic lamps with LED lamps for pedestrian traffic signal lights.

9.2.15.4 Baseline Equipment Definition

The baseline case refers to incandescent traffic lamps for pedestrian traffic signal lights.

9.2.15.5 Efficient Equipment Definition

The efficient case refers to LED traffic lamps for pedestrian traffic signal lights and may include motion sensors.

9.2.15.6 Unit Basis

This measure's incentive, savings, and incremental measure cost are determined on a "per lamp" basis.

9.2.15.7 Effective Useful Life

This measure has an effective useful life of 10 years determined from estimated LED lifetime and from annual hours of operation.

9.2.15.8 Incremental Measure Cost

The incremental cost for this measure includes the total material and labor costs. Incremental costs are derived from contractor interviews and secondary sources. Specific incremental costs can be found in Table 9-19.

9.2.15.9 Annual Energy Savings Algorithm

The following algorithm is used to estimate annual energy saving impacts for this measure. Numeric values for the variables can be found in Table 9-19.

$$\Delta kWh = \frac{(W_{base} - W_{ee})}{1000} \times OpHrs$$

Where:

ΔkWh	=	Energy savings for measure (in kWh)
W_{base}	=	Baseline Wattage of Lamp
W_{ee}	=	Efficient Wattage of Lamp
OpHrs	=	Hours of Operation

9.2.15.10 Coincident Peak Demand Savings Algorithm

The following algorithm is used to estimate annual coincident peak demand saving impacts for this measure. Numeric values for the variables can be found in Table 9-19.

$$\Delta kW_{Coincident} = \frac{(W_{base} - W_{ee})}{1000} \times DF \times CF$$

Where:

$\Delta kW_{coincident}$	=	Coincident peak demand savings for this measure (in kW)
W_{base}	=	Baseline Wattage of Lamp
W_{ee}	=	Efficient Wattage of Lamp
DF	=	Diversity Factor
CF	=	Coincidence Factor

9.2.15.11 Algorithm Input Values by Measure

The values presented in the following table are based on historical participation data for the Solutions for Business programs. Values are weighted averages based on the sector-specific values presented in Table 9-1.

Table 9-19. Measure Lookup Values - LED Pedestrian Signs

Measure Sub-Category	Measure	OpHrs	CF	DF	W_{base}	W_{ee}	Incremental Cost ($/lamp)
LED Lighting	Pedestrian NO countdown	5432	1.00	0.62	132	8	$190.66
LED Lighting	Pedestrian W/ countdown	6483	1.00	0.74	132	8.9	$238.66

9.2.16 LED Lighting (LED Lamps)

9.2.16.1 Applicability

Retrofit

9.2.16.2 Applicable Programs

This measure is applicable to APS' Solutions for Business programs, which include:

- Large Existing
- New Construction
- Small Business
- Schools

9.2.16.3 Measure Description

This lighting end-use measure promotes the replacement of existing incandescent or halogen lamps with LED lamps.

9.2.16.4 Baseline Equipment Definition

The baseline case refers to incandescent or halogen lamps of 100 watts or less.

9.2.16.5 Efficient Equipment Definition

The efficient case refers to LED lamps including reflector lamps of the R, BR, or PAR series.

9.2.16.6 Unit Basis

This measure's incentive, savings, and incremental measure cost are determined on a "per lamp" basis.

9.2.16.7 Effective Useful Life

This measure has an effective useful life of 7 years based on estimated LED lifetime and from annual hours of operation.

9.2.16.8 Incremental Measure Cost

The incremental cost for this measure, which only includes total material costs, varies depending on wattages of different LED lamps and whether such lamps have reflectors. Incremental costs are derived from contractor interviews and secondary sources. Specific incremental costs can be found in Table 9-20.

9.2.16.9 Annual Energy Savings Algorithm

The following algorithm is used to estimate annual energy saving impacts for this measure. Numeric values for the variables can be found in Table 9-20.

$$\Delta kWh = \frac{(W_{base} - W_{ee})}{1000} \times OpHrs \times (1 + EIF)$$

Where:

ΔkWh	=	Energy savings for measure (in kWh)
W_{base}	=	Baseline Wattage of Lamp
W_{ee}	=	Efficient Wattage of Lamp
OpHrs	=	Hours of Operation
EIF	=	Energy Interaction Factor

9.2.16.10 Coincident Peak Demand Savings Algorithm

The following algorithm is used to estimate annual coincident peak demand saving impacts for this measure. Numeric values for the variables can be found in Table 9-20.

$$\Delta kW_{coincident} = \frac{(W_{base} - W_{ee})}{1000} \times (1 + DIF) \times DF \times CF$$

Where:

$\Delta kW_{coincident}$	=	Coincident peak demand savings for this measure (in kW)
W_{base}	=	Baseline Wattage of Lamp
W_{ee}	=	Efficient Wattage of Lamp
DIF	=	Demand Interaction Factor
DF	=	Diversity Factor
CF	=	Coincidence Factor

9.2.16.11 Algorithm Input Values by Measure

The values presented in the following table are based on historical participation data for the Solutions for Business programs. Values are weighted averages based on the sector-specific values presented in Table 9-1.

Table 9-20. Measure Lookup Values - LED Lamps

Measure Sub-Category	Measure	OpHrs	DIF	EIF	CF	DF	W_{base}	W_{ee}	Incremental Cost ($/lamp)
LED Lighting	LED Lamps NO Reflector	3676	0.20	0.17	0.71	1.00	52.1	7.8	$26.68
LED Lighting	LED Lamps W/ Reflector	3676	0.20	0.17	0.71	1.00	57.3	11.4	$42.25

9.2.17 LED Lighting (MR-16 LED Lamps)

9.2.17.1 Applicability

Retrofit

9.2.17.2 Applicable Programs

This measure is applicable to APS' Solutions for Business programs, which include:

- Large Existing
- New Construction
- Small Business
- Schools

9.2.17.3 Measure Description

This lighting end-use measure promotes the replacement of existing halogen lamps with multifaceted reflector (MR)-16 LED lamps.

9.2.17.4 Baseline Equipment Definition

The baseline case refers to halogen lamps.

9.2.17.5 Efficient Equipment Definition

The efficient case refers to MR-16 LED lamps that have the same format for halogen bulbs.

9.2.17.6 Unit Basis

This measure's incentive, savings, and incremental measure cost are determined on a "per lamp" basis.

9.2.17.7 Effective Useful Life

This measure has an effective useful life of 7 years determined from estimated LED lifetime and from annual hours of operation.

9.2.17.8 Incremental Measure Cost

The incremental cost for this measure, which only includes total material costs, varies depending on wattages of different MR-16 LED lamps. Incremental costs are derived from contractor interviews and secondary sources. Specific incremental costs can be found in Table 9-21.

9.2.17.9 Annual Energy Savings Algorithm

The following algorithm is used to estimate annual energy saving impacts for this measure. Numeric values for the variables can be found in Table 9-21.

$$\Delta kWh = \frac{(W_{base} - W_{ee})}{1000} \times OpHrs \times (1 + EIF)$$

Where:

ΔkWh	=	Energy savings for measure (in kWh)
W_{base}	=	Baseline Wattage of Lamp
W_{ee}	=	Efficient Wattage of Lamp
OpHrs	=	Hours of Operation
EIF	=	Energy Interaction Factor

9.2.17.10 Coincident Peak Demand Savings Algorithm

The following algorithm is used to estimate annual coincident peak demand saving impacts for this measure. Numeric values for the variables can be found in Table 9-21.

$$\Delta kW_{coincident} = \frac{(W_{base} - W_{ee})}{1000} \times (1 + DIF) \times DF \times CF$$

Where:

$\Delta kW_{coincident}$	=	Coincident peak demand savings for this measure (in kW)
W_{base}	=	Baseline Wattage of Lamp
W_{ee}	=	Efficient Wattage of Lamp
DIF	=	Demand Interaction Factor
DF	=	Diversity factor
CF	=	Coincidence Factor

9.2.17.11 Algorithm Input Values by Measure

The values presented in the following table are based on historical participation data for the Solutions for Business programs. Values are weighted averages based on the sector-specific values presented in Table 9-1.

Table 9-21. Measure Lookup Values - MR-16 LED Lamps

Measure Sub-Category	Measure	OpHrs	DIF	EIF	CF	DF	W_{base}	W_{ee}	Incremental Cost ($/lamp)
LED Lighting	MR-16 LED Lamps	3675	0.20	0.17	0.71	1.00	39.2	4.8	$38.83

9.2.18 LED Lighting (Refrigerated Case LEDs)

9.2.18.1 Applicability

Replace on Burnout and New Construction

9.2.18.2 Applicable Programs

This measure is applicable to APS' Solutions for Business programs, which include:

» Large Existing
» New Construction
» Small Business
» Schools

9.2.18.3 Measure Description

This lighting end-use measure promotes the replacement of existing 5-foot or 6-foot T12 or T8 linear fluorescent lamps with LED lamps in refrigerated and freezer cases.

9.2.18.4 Baseline Equipment Definition

The baseline case refers to 5-foot or 6-foot T12 or T8 linear fluorescent lamps.

9.2.18.5 Efficient Equipment Definition

The efficient case refers to 5-foot or 6-foot LED lamps and may include motion sensors.

9.2.18.6 Unit Basis

This measure's incentive, savings, and incremental measure cost are determined on a "per lamp" basis.

9.2.18.7 Effective Useful Life

This measure has an effective useful life of 6 years determined from estimated LED lifetime and from annual hours of operation.

9.2.18.8 Incremental Measure Cost

The incremental cost for this measure, which only includes total material costs, varies depending on whether LED lamps have motion sensors. Incremental costs are derived from contractor interviews and secondary sources. Specific incremental costs can be found in Table 9-22.

9.2.18.9 Annual Energy Savings Algorithm

The following algorithm is used to estimate annual energy saving impacts for this measure. Numeric values for the variables can be found in Table 9-22.

$$\Delta kWh = \frac{(W_{base} - W_{ee})}{1000} \times OpHrs \times (1 + EIF)$$

Where:

ΔkWh	=	Energy savings for measure (in kWh)
W_{base}	=	Baseline Wattage of Lamp
W_{ee}	=	Efficient Wattage of Lamp
OpHrs	=	Hours of Operation
EIF	=	Energy Interaction Factor

9.2.18.10 Coincident Peak Demand Savings Algorithm

The following algorithm is used to estimate annual coincident peak demand saving impacts for this measure. Numeric values for the variables can be found in Table 9-22.

$$\Delta kW_{Coincident} = \frac{(W_{base} - W_{ee})}{1000} \times (1 + DIF) \times DF \times CF$$

Where:

$\Delta kW_{coincident}$ = Coincident peak demand savings for this measure (in kW)
W_{base} = Baseline Wattage of Lamp
W_{ee} = Efficient Wattage of Lamp
DIF = Demand Interaction Factor
DF = Diversity factor
CF = Coincidence Factor

9.2.18.11 Algorithm Input Values by Measure

The values presented in the following table are based on historical participation data for the Solutions for Business programs. Values are weighted averages based on the sector-specific values presented in Table 9-1.

Table 9-22. Measure Lookup Values - Refrigerated Case LED Lighting

Measure Sub-Category	Measure	OpHrs	DIF	EIF	CF	DF	W_{base}	W_{ee}	Incremental Cost ($/lamp)
LED Lighting	Refrigerated Case LED Lamps NO motion Sensors	8634	0.25	0.25	1.00	1.00	72.5	21.8	$124.55
LED Lighting	Refrigerated Case LED Lamps W/ motion Sensors	6043	0.25	0.25	1.00	1.00	72.5	21.8	$129.08

9.2.19 LED Lighting (Linear LEDs)

9.2.19.1 Applicability

Retrofit

9.2.19.2 Applicable Programs

This measure is applicable to APS' Solutions for Business programs, which include:

» Large Existing
» New Construction
» Small Business
» Schools

9.2.19.3 Measure Description

This lighting end-use measure promotes the replacement of existing T8 linear fluorescents lamps with Linear LED lamps.

9.2.19.4 Baseline Equipment Definition

The baseline case refers to T8 linear fluorescent T8 lamps with electronic ballasts.

9.2.19.5 Efficient Equipment Definition

The efficient case refers to Linear LED lamps that install directly into existing ballasts.

9.2.19.6 Unit Basis

This measure's incentive, savings, and incremental measure cost are determined on a "per lamp" basis.

9.2.19.7 Effective Useful Life

This measure has an effective useful life of 17 years based on estimated LED lifetime and from annual hours of operation.

9.2.19.8 Incremental Measure Cost

The incremental cost for this measure, which only includes total material costs and varies depending on wattages of different LED lamps. Incremental costs are derived from the secondary sources. Specific incremental costs can be found in Table 9-23.

9.2.19.9 Annual Energy Savings Algorithm

The following algorithm is used to estimate annual energy saving impacts for this measure. Numeric values for the variables can be found in Table 9-23.

$$\Delta kWh = \frac{(W_{base} - W_{ee})}{1000} \times OpHrs \times (1 + EIF)$$

Where:

ΔkWh	=	Energy savings for measure (in kWh)
W_{base}	=	Baseline Wattage of Lamp
W_{ee}	=	Efficient Wattage of Lamp
OpHrs	=	Hours of Operation
EIF	=	Energy Interaction Factor

9.2.19.10 Coincident Peak Demand Savings Algorithm

The following algorithm is used to estimate annual coincident peak demand saving impacts for this measure. Numeric values for the variables can be found in Table 9-23.

$$\Delta kW_{Coincident} = \frac{(W_{base} - W_{ee})}{1000} \times (1 + DIF) \times DF \times CF$$

Where:

$\Delta kW_{coincident}$	=	Coincident peak demand savings for this measure (in kW)
W_{base}	=	Baseline Wattage of Lamp
W_{ee}	=	Efficient Wattage of Lamp
DIF	=	Demand Interaction Factor
DF	=	Diversity Factor
CF	=	Coincidence Factor

9.2.19.11 Algorithm Input Values by Measure

The values presented in the following table are based on historical participation data for the Solutions for Business programs. Values are weighted averages based on the sector-specific values for linear fluorescents presented in Table 9-1.

Table 9-23. Measure Lookup Values – Linear LED Lamps

Measure Sub-Category	Measure	OpHrs	DIF	EIF	CF	DF	W_{base}	W_{ee}	Incremental Cost ($/lamp)
LED Lighting	T8 to Linear LED 2-foot lamp	2,981	0.15	0.13	0.65	.80	17	9	$8.03
LED Lighting	T8 to Linear LED 3-foot lamp	2,981	0.15	0.13	0.65	.80	26	12	$10.38
LED Lighting	T8 to Linear LED 4-foot lamp	2,981	0.15	0.13	0.65	.80	31	17	$14.89
LED Lighting	T8 to Linear LED 8-foot lamp	2,981	0.15	0.13	0.65	.80	59	38	$29.52

10. SOLUTIONS FOR BUSINESS – HVAC AND COOLING

10.1 Algorithm Inputs

10.1.1 Hours of Operation/ Effective Full Load Hours (EFLH)

The EFLH is defined as the total number of hours that equipment is in full operation. Annual hours of operation for different measure types are derived from a combination of data from the U.S. Department of Energy's (DOE) Benchmark Prototype Models[65] and the EUDAP conducted by APS. Variations within measures are due to different operating conditions for different buildings.

10.1.2 Load Factor (LF)

The LF is the ratio of maximum operating power or capacity of a measure to its nameplate power or capacity. Values are based on engineering models and secondary literature reviews specific to commercial refrigeration equipment.

10.1.3 Coincidence Factor (CF)

The CF is the fraction of the peak demand of a population that is in operation at the time of APS' system peak. Values are based on engineering models and secondary literature reviews specific to HVAC equipment.

10.1.4 Energy Efficiency Ratio (EER)

The EER is defined as the ratio of net cooling capacity – or heat removed in Btu/h – to the total input rate of electric power applied in Watts. For AC units with ≤ 65,000 Btu/h, SEER should be used for cooling savings.

10.1.5 Seasonal Energy Efficiency Ratio (SEER)

The SEER is the cooling output during a typical cooling-season divided by the total electric energy input during the same period. For AC units with ≥ 65,000 Btu/h, EER should be used for cooling demand savings.

10.1.6 Integrated Energy Efficiency Ratio (IEER)

The IEER is the cooling part-load EER efficiency for commercial unitary air conditioning equipment on the basis of weighted operation at various load capacities. For 3 phase AC units with ≥ 65,000 Btu/h, IEER should be used for cooling energy savings.

[65] http://www.energycodes.gov/development/commercial/90.1_models

10.1.7 Heating Seasonal Performance Factor (HSPF)

The HSPF is the heat output over the heating season divided by the electricity input during the same period.

10.1.8 Integrated part-load value (IPLV)

The IPLV is a weighted average of efficiency measurements at various part-load conditions and is a standardized way of comparing equipment (e.g., air-cooled chiller) at conditions more representative of field conditions.

10.1.9 Full-load value (FLV)

The FLV refers to a rating value attributed to equipment efficiency at full-load conditions.

10.2 Measure Characterization

10.2.1 Single-Phase Package and Split System Unitary Equipment

10.2.1.1 Applicability

Replace on Burnout and New Construction

10.2.1.2 Applicable Programs

This measure is applicable to APS' Solutions for Business programs, which include:

» Large Existing
» New Construction
» Small Business
» Schools

10.2.1.3 Measure Description

This HVAC measure promotes the installation of high-efficiency unitary single phase equipment, both single-phase package and split system. This measure could apply to the replacing of an existing unit at the end of its useful life or the installation of a new unit in a new or existing building. The incentive is determined by two components: an equipment incentive and an efficiency incentive, which are applied per ton of cooling installed.

10.2.1.4 Baseline Equipment Definition

Table 10-1: Baseline Equipment Efficiencies

Measure	$SEER_{base}$	EER_{base}
Packaged and Splits Single Phase AC ≤ 65,000 Btu/h	13.0	11.0

Source: ASHRAE 90.1 2004 Standards

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10.2.1.5 Efficient Equipment Definition

All packaged and split system cooling equipment must meet Air-Conditioning and Refrigeration Institute (AHRI) standards (210/240-2008 or 340/360-2007), be UL listed and use a minimum ozone-depleting refrigerant (e.g., HCFC or HFC). Equipment that meets the minimum qualifying efficiency rating is eligible for an incentive. Equipment that exceeds the minimum qualifying efficiencies in Table 10-2 for the equipment size category is eligible for an efficiency incentive (added on a prorated basis).

Table 10-2: Minimum Qualifying Efficiencies

Measure	Tier	$SEER_{min}$	EER_{min}
Split Single Phase AC ≤ 65,000 Btu/h	0	N/A	N/A
	1	14.0	12.0
	2	15.0	12.5
Packaged Single Phase AC ≤ 65,000 Btu/h	0	N/A	N/A
	1	14.0	11.6
	2	15.0	12.0

Source: CEE Commercial Unitary AC and HP Specification Efficiency Requirements

10.2.1.6 Unit Basis

This measure's savings and incremental measure cost are determined on a "per kBtu/h" basis.

10.2.1.7 Effective Useful Life

This measure has an effective useful life of 15 years determined from DEER 2008[66].

10.2.1.8 Incremental Measure Cost

The incremental cost per ton for this measure varies depending on the unit type, unit size, and unit S/EER and includes the total material and labor costs. Incremental costs are based on participating contractor interviews and review of program invoices. For details of specific incremental cost calculations, refer to the MAS.

10.2.1.9 Annual Energy Savings Algorithm

The following algorithm is used to estimate annual energy saving impacts per ton for this measure. Numeric values for the variables can be found in Table 10-3.

$$\Delta kWh = \left(\frac{1}{SEER_{base}} - \frac{1}{SEER_{ee}}\right) \times 12 \times EFLH$$

[66] http://www.deeresources.com/

Where:

ΔkWh	=	Energy savings for measure (in kWh/ton)
$SEER_{base}$	=	Efficiency of the baseline equipment
$SEER_{ee}$	=	Efficiency of the efficient equipment
EFLH	=	Effective Full Load Hours

10.2.1.10 Coincident Peak Demand Savings Algorithm

The following algorithm is used to estimate coincident peak demand saving impacts per ton for this measure. Numeric values for the variables can be found in Table 10-3.

$$\Delta kW_{Coincident} = \left(\frac{1}{EER_{base}} - \frac{1}{EER_{ee}}\right) \times 12 \times LF \times CF$$

Where:

$\Delta kW_{coincident}$	=	Coincident peak demand savings for this measure (in kW/ton)
EER_{base}	=	Efficiency of the baseline equipment, expressed as SEER or EER
EER_{ee}	=	Efficiency of the efficient equipment, expressed as SEER or EER
CF	=	Coincidence Factor
LF	=	Load Factor

10.2.1.11 Algorithm Input Values by Measure

For baseline values, refer to Table 10-1.

Table 10-3: Measure Lookup Values - Single Phase Unitary Equipment

Measure Type	$SEER_{ee}$	EER_{ee}	EFLH	CF	LF	Incremental Cost ($/kBtuh)
Packaged and Splits Single Phase AC ≤ 65,000 Btu/h	14.3	12.0	2378	0.88	1.0	$10.20
	15.1	12.4	2378	0.88	1.0	$12.00
	16.1	12.6	2378	0.88	1.0	$21.40
	17.0	12.8	2378	0.88	1.0	$39.10
	20.0	13.6	2378	0.88	1.0	$136.80

10.2.2 Three-Phase Package and Split System Unitary Equipment

10.2.2.1 Applicability

Replace on Burnout and New Construction

10.2.2.2 Applicable Programs

This measure is applicable to APS' Solutions for Business programs, which include:

- Large Existing
- New Construction
- Small Business
- Schools

10.2.2.3 Measure Description

This HVAC measure promotes the installation of high-efficiency unitary three phase equipment, both package and split system. This measure could apply to the replacing of an existing unit at the end of its useful life or the installation of a new unit in a new or existing building. The incentive is determined by two components: an equipment incentive and an efficiency incentive, which are applied per ton of cooling installed.

10.2.2.4 Baseline Equipment Definition

Table 10-4: Baseline Equipment Efficiencies

Measure Size	Tier	$SEER_{base}$	$IEER_{base}$	EER_{base}	$HSPF_{base}$
<65kBtu/h	1	13.0		11.2	7.7
	2	13.0		11.2	7.7
65-135kBtu/h	0		11.2	11.0	11.3
	1		11.2	11.0	11.3
	2		11.2	11.0	11.3
135-240kBtu/h	0		10.8	10.8	10.9
	1		10.8	10.8	10.9
	2		10.8	10.8	10.9
≥240kBtu/h	0		10.1	9.8	10.9
	1		10.1	9.8	10.9
	2		10.1	9.8	10.9

Source: ASHRAE 90.1 2004 Standards, EERE Appliance Standards, AHRI Database

10.2.2.5 Efficient Equipment Definition

All packaged and split system cooling equipment must meet Air-Conditioning and Refrigeration Institute (AHRI) standards (210/240-2008 or 340/360-2007), be UL listed and use a minimum ozone-depleting refrigerant (e.g., HCFC or HFC). Equipment that meets the minimum qualifying efficiency rating is eligible for an incentive. Equipment that exceeds the minimum qualifying efficiency for the equipment size category is eligible for an efficiency incentive (added on a prorated basis).

Table 10-5: Minimum Qualifying Efficiencies

Measure Size	Heating Section Type	Subcategory	Tier	$SEER_{min}$	$IEER_{base}$	EER_{min}
<65kBtu/h	All	Split System	1	14.0		12.0
			2	15.0		12.5
		Single Package	1	14.0		11.6
			2	15.0		12.0
65-135kBtu/h	Electric Resistance	Split System & Single Package	0		11.8	11.7
			1		13.0	11.7
			2		14.0	12.2
	All Other	Split System & Single Package	0		11.6	11.5
			1		12.8	11.5
			2		13.8	12.0
135-240kBtu/h	Electric Resistance	Split System & Single Package	0		11.8	11.7
			1		12.5	11.7
			2		13.2	12.2
	All Other	Split System & Single Package	0		11.6	11.5
			1		12.3	11.5
			2		13.0	12.0
≥240kBtu/h	Electric Resistance	Split System & Single Package	0		10.6	10.5
			1		11.3	10.5
			2		12.3	10.8
	All Other	Split System & Single Package	0		10.4	10.3
			1		11.1	10.3
			2		12.1	10.6

Source: CEE Commercial Unitary AC and HP Specification Efficiency Requirements

10.2.2.6 Unit Basis

This measure's savings and incremental measure cost are determined based on a "per kBtu/h" basis.

10.2.2.7 Effective Useful Life

This measure has an effective useful life of 20 years determined from DEER 2008[67].

10.2.2.8 Incremental Measure Cost

The incremental cost per ton for this measure varies depending on the unit type, unit size, and unit S/IEER and includes the total material and labor costs. Incremental costs are based on participating contractor interviews and review of program invoices. For details of specific incremental cost calculations, refer to the MAS.

10.2.2.9 Annual Energy Savings Algorithm

The following algorithm is used to estimate annual energy saving impacts per kBtu/h for this measure. For AC units ≤ 65,000 Btu/h, use SEER instead of IEER to calculate ΔkWh. Numeric values for the variables can be found in Table 10-6.

$$\Delta kWh = [(\frac{1}{S/IEER_{base}} - \frac{1}{S/IEER_{ee}}) \times EFLH_{cooling} + 0.5 \times (\frac{1}{HSPF_{base}} - \frac{1}{HSPF_{ee}}) \times EFLH_{heating}]$$

Where:

ΔkWh	=	Energy savings per kBtu/h for this measure
$SEER_{base}$	=	Efficiency of the baseline equipment for units <65 kBtuh
$SEER_{ee}$	=	Efficiency of the efficient equipment for units <65 kBtuh
$IEER_{base}$	=	Efficiency of the baseline equipment
$IEER_{ee}$	=	Efficiency of the efficient equipment
$HSPF_{base}$	=	Heating Seasonal Performance Factor
$HSPF_{ee}$	=	Heating Seasonal Performance Factor
$EFLH_{cooling}$	=	Cooling Effective Full Load Hours
$EFLH_{heating}$	=	Heating Effective Full Load Hours
0.5	=	Proportion of heat pumps

10.2.2.10 Coincident Peak Demand Savings Algorithm

The following algorithm is used to estimate coincident peak demand saving impacts per kBtu/h for this measure. Numeric values for the variables can be found in Table 10-6.

$$\Delta kW_{Coincident} = (\frac{1}{EER_{base}} - \frac{1}{EER_{ee}}) \times LF \times CF$$

Where:

$\Delta kW_{coincident}$	=	Coincident peak demand savings per kBtu/h for this measure

[67] http://www.deeresources.com/

EER_{base}	=	Efficiency of the baseline equipment
EER_{ee}	=	Efficiency of the efficient equipment
CF	=	Coincidence Factor
LF	=	Load Factor

10.2.2.11 Algorithm Input Values by Measure

For baseline values, refer to Table 10-4.

Table 10-6: Measure Lookup Values - Three-Phase Unitary Equipment

Measure Size	Tier	$SEER_{ee}$	$IEER_{ee}$	EER_{ee}	$HSPF_{ee}$	$EFLH_{cooling}$	$EFLH_{heating}$	CF	LF	Incremental Cost ($/kBtu/h)
<65kBtu/h	1	14.0		11.7	8.3	2497	227	0.88	1.0	13.63
	2	15.0		12.1	8.8	2497	227	0.88	1.0	18.07
65-135kBtu/h	0		11.7	11.4	11.6	2497	227	0.88	1.0	7.18
	1		12.9	11.4	11.6	2497	227	0.88	1.0	10.66
	2		13.9	12.1	11.6	2497	227	0.88	1.0	14.13
135-240kBtu/h	0		11.7	11.2	10.9	2497	227	0.88	1.0	8.53
	1		12.4	11.2	10.9	2497	227	0.88	1.0	12.66
	2		13.1	12.1	10.9	2497	227	0.88	1.0	16.78
≥240kBtu/h	0		10.5	10.3	10.9	2497	227	0.88	1.0	9.60
	1		11.2	10.3	10.9	2497	227	0.88	1.0	14.24
	2		12.2	10.7	10.9	2497	227	0.88	1.0	18.89

10.2.3 Packaged Terminal Air Conditioners and Heat Pumps

10.2.3.1 Applicability

Replace on Burnout and New Construction

10.2.3.2 Applicable Programs

This measure is applicable to APS' Solutions for Business programs, which include:

» Large Existing
» New Construction

- Small Business
- Schools

10.2.3.3 Measure Description

This HVAC measure promotes the installation of packaged terminal air conditioners and heat pumps. This measure could apply to the replacing of an existing unit at the end of its useful life or the installation of a new unit in a new or existing building. The incentive is determined by two components: an equipment incentive and an efficiency incentive, which are applied per ton of cooling installed.

10.2.3.4 Baseline Equipment Definition

Table 10-7: Baseline Equipment Efficiencies

Measure	Size Range (kBtuh)	EER_{base}
Packaged Terminal AC	7.0	10.69
Packaged Terminal AC	8.0	10.68
Packaged Terminal AC	10.0	10.22
Packaged Terminal AC	12.9	9.64

10.2.3.5 Efficient Equipment Definition

All packaged units must meet Air-Conditioning and Refrigeration Institute (AHRI) standards (210/240-2008 or 340/360-2007), be UL listed and use a minimum ozone-depleting refrigerant (e.g., HCFC or HFC). Equipment that meets the minimum qualifying efficiencies in Table 10-8 is eligible for an incentive. Equipment that exceeds the minimum qualifying efficiency for the equipment size category is eligible for an efficiency incentive (added on a prorated basis).

Table 10-8: Minimum Qualifying Efficiencies

Measure	Size Range (kBtuh)	EER_{min}
Packaged Terminal AC	7.0	11.01
Packaged Terminal AC	8.0	10.79
Packaged Terminal AC	10.0	10.37
Packaged Terminal AC	12.9	9.75

Source: ASHRAE 90.1 2004 Standards

10.2.3.6 Unit Basis

This measure's savings and incremental measure cost are determined based on a "per kBtu/h" basis.

10.2.3.7 Effective Useful Life

This measure has an effective useful life of 15 years determined from DEER 2008[68].

10.2.3.8 Incremental Measure Cost

The incremental cost per ton for this measure varies depending on the unit type, unit size, and unit EER and includes the total material and labor costs. Incremental costs are based on DEER data. For details of specific incremental cost calculations, refer to the MAS.

10.2.3.9 Annual Energy Savings Algorithm

The following algorithm is used to estimate annual energy saving impacts per kBtu/h for this measure. Numeric values for the variables can be found in Table 10-9.

$$\Delta kWh = \left(\frac{1}{EER_{base}} - \frac{1}{EER_{ee}}\right) \times EFLH$$

Where:

ΔkWh	=	Energy savings per kBtu/h for this measure
EER_{base}	=	Efficiency of the baseline equipment, expressed as EER
EER_{ee}	=	Efficiency of the efficient equipment, expressed as EER
EFLH	=	Effective Full Load Hours

10.2.3.10 Coincident Peak Demand Savings Algorithm

The following algorithm is used to estimate coincident peak demand saving impacts per kBtu/h for this measure. Numeric values for the variables can be found in Table 10-9.

$$\Delta kW_{coincident} = \left(\frac{1}{EER_{base}} - \frac{1}{EER_{ee}}\right) \times CF$$

Where:

$\Delta kW_{coincident}$	=	Coincident peak demand savings per kBtu/h for this measure
EER_{base}	=	Efficiency of the baseline equipment, expressed as EER
EER_{ee}	=	Efficiency of the efficient equipment, expressed as EER
CF	=	Coincidence Factor

10.2.3.11 Algorithm Input Values by Measure

For baseline values, refer to Table 10-7.

[68] http://www.deeresources.com/

Table 10-9: Measure Lookup Values - Packaged Terminal Equipment

Measure Type	Size Range (kBtuh)	Avg. Unit Size (kBtuh)	EER_{ee}	EFLH	CF	Incremental Cost ($/unit)
Packaged Terminal AC	0.0-7.0	7.0	12.40	4588	0.95	112
Packaged Terminal AC	7.1-9.0	8.0	12.20	4588	0.95	125
Packaged Terminal AC	9.1-12.0	10.0	11.75	4588	0.95	138
Packaged Terminal AC	12.1+	12.9	10.48	4588	0.95	127

10.2.4 Water-Cooled Chillers

10.2.4.1 Applicability

Replace on Burnout and New Construction

10.2.4.2 Applicable Programs

This measure is applicable to APS' Solutions for Business programs, which include:

- Large Existing
- New Construction
- Small Business
- Schools

10.2.4.3 Measure Description

This HVAC measure promotes the installation of high-efficiency water-cooled chillers. This measure could apply to the replacing of an existing unit at the end of its useful life or the installation of a new unit in a new or existing building. The incentive is determined by two components: an equipment incentive and an efficiency incentive, which are applied per ton of cooling installed.

10.2.4.4 Baseline Equipment Definition

Table 10-10: Water-Cooled Chillers Baseline Equipment Efficiencies

Measure	Size	$IPLV_{base}$ (kW/ton)	FLV_{base} (kW/ton)
Water-Cooled Chillers	< 150 Tons	0.71	0.79
	150-300 Tons	0.64	0.72
	>300 Tons	0.57	0.64

Source: ASHRAE 90.1 2004

10.2.4.5 Efficient Equipment Definition

Chiller must meet ARI standards 550/590-2003, be UL listed and use a minimum ozone-depleting refrigerant (e.g., HCFC or HFC). The ARI net capacity value should be used to determine the chiller tones. Chiller efficiency rating must be based on ARI Standard 550/590-2003 for IPLV Standard Conditions and not based on full-load conditions. Equipment that meets the minimum qualifying efficiency rating is eligible for an incentive. Minimum qualifying efficiency ratings for chillers are same with baseline equipment efficiencies, for minimum qualifying efficiencies see Table 10-10. Equipment that exceeds the minimum qualifying efficiency for the equipment size category is eligible for an efficiency incentive (added on a prorated basis). For energy efficient equipment values, refer to the Table 10-11.

10.2.4.6 Unit Basis

This measure's savings and incremental measure cost are determined based on a "per ton" basis.

10.2.4.7 Effective Useful Life

This measure has an effective useful life of 20 years determined from DEER 2008[69].

10.2.4.8 Incremental Measure Cost

The incremental cost per ton for this measure varies depending on the unit type, unit size, and unit IPLV and includes the total material and labor costs. Incremental costs are sourced from DEER 2008. For details of specific incremental cost calculations, refer to the MAS.

10.2.4.9 Annual Energy Savings Algorithm

The following algorithm is used to estimate annual energy saving impacts per ton for this measure. Numeric values for the variables can be found in Table 10-11.

$$\Delta kWh = (IPLV_{base} - IPLV_{ee}) \times SF \times F \times EFLH$$

Where:

ΔkWh	=	Energy savings for measure (in kWh)
$IPLV_{ee}$	=	Integrated Part Load Value for the efficient chiller (kW/ton)
$IPLV_{base}$	=	Integrated Part Load Value for the baseline chiller (kW/ton)
SF	=	Sizing Factor
F	=	APLV to IPLV conversion factor
EFLH	=	Effective Full Load Hours

[69] http://www.deeresources.com/

10.2.4.10 Coincident Peak Demand Savings Algorithm

The following algorithm is used to estimate coincident peak demand saving impacts per ton for this measure. Numeric values for the variables can be found in Table 10-11.

$$\Delta kW_{coincident} = (FLV_{base} - FLV_{ee}) \times SF \times CF$$

Where:

$\Delta kW_{coincident}$	=	Coincident peak demand savings for this measure (in kW)
FLV_{ee}	=	Full Load Value for the efficient chiller (kW/ton)
FLV_{base}	=	Full Load Value for the baseline chiller (kW/ton)
CF	=	Coincidence Factor
SF	=	Sizing Factor

10.2.4.11 Algorithm Input Values by Measure

For baseline values, refer to Table 10-10.

Table 10-11: Measure Lookup Values - Water-Cooled Chillers

Measure Type	Size	FLV_{ee}	$IPLV_{ee}$	APLV-IPLV Factor (F)	EFLH	CF	SF	Incremental Cost ($/ton)
Water-Cooled Chillers	<150 tons	0.79	0.680	1.044	2206	0.91	0.8	30
		0.77	0.622	1.071	2206	0.91	0.8	92
		0.75	0.573	1.027	2206	0.91	0.8	142
		0.71	0.436	1.033	2206	0.91	0.8	258
Water-Cooled Chillers	150-300 tons	0.72	0.565	1.082	2206	0.91	0.8	82
		0.65	0.533	1.059	2206	0.91	0.8	117
		0.63	0.519	1.053	2206	0.91	0.8	132
		0.64	0.475	1.048	2206	0.91	0.8	178
		0.63	0.435	1.047	2206	0.91	0.8	221
		0.62	0.423	1.071	2206	0.91	0.8	233
		0.63	0.340	1.017	2206	0.91	0.8	323
Water-Cooled Chillers	>300 tons	0.59	0.551	1.004	2206	0.91	0.8	23
		0.58	0.514	1.040	2206	0.91	0.8	63
		0.57	0.495	1.040	2206	0.91	0.8	83
		0.54	0.434	1.044	2206	0.91	0.8	146

	0.60	0.390	1.054	2206	0.91	0.8	193
	0.59	0.356	1.062	2206	0.91	0.8	230
	0.53	0.327	1.039	2206	0.91	0.8	262

10.2.5 Air-Cooled Chillers

10.2.5.1 Applicability

Replace on Burnout and New Construction

10.2.5.2 Applicable Programs

This measure is applicable to APS' Solutions for Business programs, which include:

» Large Existing
» New Construction
» Small Business
» Schools

10.2.5.3 Measure Description

This HVAC measure promotes the installation of high-efficiency air-cooled chillers. This measure could apply to the replacing of an existing unit at the end of its useful life or the installation of a new unit in a new or existing building. The incentive is determined by two components: an equipment incentive and an efficiency incentive, which are applied per ton of cooling installed.

10.2.5.4 Baseline Equipment Definition

Table 10-12: Air-Cooled Chillers Baseline Equipment Efficiencies

Measure	Size	$IPLV_{base}$ (kW/ton)	FLV_{base} (kW/ton)
Air-Cooled Chillers	< 150 Tons	1.15	1.26
Air-Cooled Chillers	≥150 Tons	1.15	1.26

Source: ASHRAE 90.1 2004

10.2.5.5 Efficient Equipment Definition

Chiller must meet ARI standards 550/590-2003, be UL listed and use a minimum ozone-depleting refrigerant (e.g., HCFC or HFC). The ARI net capacity value should be used to determine the chiller tones. Chiller efficiency rating must be based on ARI Standard 550/590-2003 for IPLV Standard Conditions and not based on full-load conditions. Equipment that meets the minimum qualifying efficiency rating is eligible for an incentive. Minimum qualifying efficiency ratings for chillers are same with baseline equipment efficiencies, for minimum qualifying efficiencies see Table 10-12. Equipment that exceeds the minimum qualifying efficiency for the equipment size category is eligible for an efficiency incentive (added on a prorated basis). For energy efficient equipment values, refer to the Table 10-13.

10.2.5.6 Unit Basis

This measure's savings, and incremental measure cost are determined based on a "per ton" basis.

10.2.5.7 Effective Useful Life

This measure has an effective useful life of 20 years determined from DEER 2008[70].

10.2.5.8 Incremental Measure Cost

The incremental cost per ton for this measure varies depending on the unit type, unit size, and unit IPLV and includes the total material and labor costs. Incremental costs are sourced from DEER 2008. For details of specific incremental cost calculations, refer to the MAS.

10.2.5.9 Annual Energy Savings Algorithm

The following algorithm is used to estimate annual energy saving impacts per ton for this measure. Numeric values for the variables can be found in Table 10-13.

$$\Delta kWh = (IPLV_{base} - IPLV_{ee}) \times SF \times F \times EFLH$$

Where:

ΔkWh	=	Energy savings for measure (in kWh)
$IPLV_{ee}$	=	Integrated Part Load Value for the efficient chiller (kW/ton)
$IPLV_{base}$	=	Integrated Part Load Value for the baseline chiller (kW/ton)
SF	=	Sizing Factor
F	=	APLV to IPLV conversion factor
EFLH	=	Effective Full Load Hours

10.2.5.10 Coincident Peak Demand Savings Algorithm

The following algorithm is used to estimate coincident peak demand saving impacts per ton for this measure. Numeric values for the variables can be found in Table 10-13.

$$\Delta kW_{coincident} = (FLV_{base} - FLV_{ee}) \times CF \times SF$$

Where:

$\Delta kW_{coincident}$	=	Coincident peak demand savings for this measure (in kW)
FLV_{ee}	=	Full Load Value for the efficient chiller (kW/ton)
FLV_{base}	=	Full Load Value for the baseline chiller (kW/ton)
CF	=	Coincidence Factor
SF	=	Sizing Factor

[70] http://www.deeresources.com/

10.2.5.11 Algorithm Input Values by Measure

For baseline values, refer to Table 10-12.

Table 10-13: Measure Lookup Values - Air-Cooled Chillers

Measure Type	Size	FLV_{ee}	$IPLV_{ee}$	APLV-IPLV Factor	EFLH	CF	SF	Incremental Cost ($/ton)
Air Cooled Chillers	<150 Tons	1.20	1.10	1.03	2161	0.92	0.8	29
		1.20	1.02	1.03	2161	0.92	0.8	74
		1.20	0.96	1.03	2161	0.92	0.8	107
		1.23	0.88	1.03	2161	0.92	0.8	146
		1.19	0.77	1.02	2161	0.92	0.8	212
Air Cooled Chillers	> 150 Tons	1.24	1.15	1.03	2161	0.92	0.8	38
		1.24	1.02	1.03	2161	0.92	0.8	74
		1.24	0.92	1.04	2161	0.92	0.8	123
		1.20	0.88	1.02	2161	0.92	0.8	137
		1.26	0.76	1.03	2161	0.92	0.8	201

10.2.6 Economizers

10.2.6.1 Applicability

Retrofit

10.2.6.2 Applicable Programs

This measure is applicable to APS' Solutions for Business programs, which include:

» Large Existing
» New Construction
» Small Business
» Schools

10.2.6.3 Measure Description

This HVAC measure promotes the installation of economizers on packaged cooling equipment. This measure could apply to the installation of economizers on existing units or with purchase of new units in new or existing buildings. The incentive is determined based on the capacity in tons of the cooling unit.

10.2.6.4 Baseline Equipment Definition

Baseline equipment for this measure is packaged cooling equipment with no economizers.

10.2.6.5 Efficient Equipment Definition

Economizers must be capable of automatically modulating between 5% and 95%.

10.2.6.6 Unit Basis

This measure's savings, and incremental measure cost are determined based on a "per ton" basis.

10.2.6.7 Effective Useful Life

This measure has an effective useful life of 15 years determined from DEER 2008[71].

10.2.6.8 Incremental Measure Cost

The incremental cost per ton for this measure varies depending on the unit type, unit size, and economizer and includes the total material and labor costs. For details of specific incremental cost calculations, refer to the MAS.

10.2.6.9 Annual Energy Savings Algorithm

The following algorithm is used to estimate annual energy saving impacts per ton for this measure. Numeric values for the variables can be found in Table 10-14.

$$\Delta kWh = \frac{12}{EER_{ee}} \times ESF \times EFLH$$

Where:

ΔkWh	=	Energy savings for measure (in kWh)
EER_{ee}	=	Energy Efficiency Ratio for the efficient air-cooling unit (kW/ton)
ESF	=	Energy Savings Factor
EFLH	=	Effective Full Load Hours
12	=	EER to kW/ton conversion factor

10.2.6.10 Coincident Peak Demand Savings Algorithm

There are no expected coincident peak demand savings impacts for this measure given that economizer savings are realized outside of the utility system peak.

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[71] http://www.deeresources.com/

10.2.6.11 Algorithm Input Values by Measure

Table 10-14: Measure Lookup Values - Economizers

Measure Type	Average Size	EER_{ee}	ESF	EFLH	CF	Incremental Cost ($/unit)
Economizers	11.73	9.27	10%	1969	0.87	80

10.2.7 Evaporative Sub cooling

10.2.7.1 Applicability

Retrofit

10.2.7.2 Applicable Programs

This measure is applicable to APS' Solutions for Business programs, which include:

- Large Existing
- New Construction
- Small Business
- Schools

10.2.7.3 Measure Description

This HVAC measure promotes the installation of supplemental evaporative sub cooling system on new cooling towers/heat exchanger or new evaporative fluid coolers to make existing air-cooled HVAC equipment more efficient. This measure applies to the installation of new sub cooling units on new cooling tower/heat exchangers or new evaporative fluid coolers.

10.2.7.4 Baseline Equipment Definition

Baseline equipment for this measure is new cooling tower/heat exchanger or new evaporative fluid coolers with no sub cooling. Baseline EER is calculated as 9.01Btu/W-h.

10.2.7.5 Efficient Equipment Definition

Efficient equipment must be added between the existing direct expansion (DX) condenser and the metering device. Efficient equipment must reject heat to a new cooling tower/heat exchanger or to a new evaporative fluid cooler.

10.2.7.6 Unit Basis

This measure's incentive, savings, and incremental measure cost are determined based on a "per ton" basis.

10.2.7.7 Effective Useful Life

This measure has an effective useful life of 15 years per Energy Innovation Group.

10.2.7.8 Incremental Measure Cost

The incremental cost per ton for this measure varies depending on the unit type, unit size, and sub cooling equipment and includes the total material, annual maintenance and labor costs. For details of specific incremental cost calculations, refer to the MAS.

10.2.7.9 Annual Energy Savings Algorithm

The following algorithm is used to estimate annual energy saving impacts per ton for this measure. Numeric values for the variables can be found in Table 10-15.

$$\Delta kWh = \left(\frac{1}{EER_{base}} - \frac{1}{EER_{ee}}\right) \times 12 \times EFLH$$

Where:

ΔkWh	=	Energy savings for measure (in kWh)
EER_{base}	=	Efficiency of the baseline equipment, expressed as EER
EER_{ee}	=	Efficiency of the efficient equipment, expressed as EER
EFLH	=	Effective Full Load Hours
12	=	EER to kW/ton conversion factor

10.2.7.10 Coincident Peak Demand Savings Algorithm

The following algorithm is used to estimate coincident peak demand saving impacts per ton for this measure. Numeric values for the variables can be found in Table 10-15.

$$\Delta kW_{coincident} = \left(\frac{1}{EER_{base}} - \frac{1}{EER_{ee}}\right) \times 12 \times CF$$

Where:

$\Delta kW_{coincident}$	=	Coincident peak demand savings for this measure (in kW)
EER_{base}	=	Efficiency of the baseline equipment, expressed as EER
EER_{ee}	=	Efficiency of the efficient equipment, expressed as EER
CF	=	Coincidence Factor
12	=	EER to kW/ton conversion factor

10.2.7.11 Algorithm Input Values by Measure

Table 10-15: Measure Lookup Values - Evaporative Sub-Cooling

Measure Type	EER_{base}	EER_{ee} w/subcooling	Water Consumed (gal/ton)	EFLH	CF	Incremental Cost ($/ton)
Sub cooling	9.0	14.0	438	1902	0.93	828

10.2.8 Programmable Thermostats

10.2.8.1 Applicability

Retrofit

10.2.8.2 Applicable Programs

This measure is applicable to APS' Solutions for Business programs, which include:

» Large Existing
» New Construction
» Small Business
» Schools

10.2.8.3 Measure Description

This HVAC measure promotes the installation of programmable thermostat. This measure could apply to the installation of a new unit in a new or existing building. The incentive is determined per unit basis.

10.2.8.4 Baseline Equipment Definition

Baseline equipment for this measure is a non-programmable thermostat.

10.2.8.5 Efficient Equipment Definition

Efficient equipment is a programmable thermostat with 7-day, 5-2, or 5-1-1 programming capability.

10.2.8.6 Unit Basis

This measure's savings, and incremental measure cost are determined based on a "per unit" basis. The total annual savings of thermostats are determined based on a "per sq.ft." basis.

10.2.8.7 Effective Useful Life

This measure has an effective useful life of 11 years determined from DEER 2008[72].

[72] http://www.deeresources.com/

10.2.8.8 Incremental Measure Cost

The incremental cost can be found in Table 10-16.

10.2.8.9 Annual Energy Savings Algorithm

Numeric values for the variables can be found in Table 10-16. Savings for programmable thermostats are based on calibrated energy simulation modeling and thus presented as deemed savings. The total annual savings of thermostats are determined based on a "per sq.ft." basis.

10.2.8.10 Coincident Peak Demand Savings Algorithm

Numeric values for the deemed savings values and the variables can be found in Table 10-16.

10.2.8.11 Algorithm Input Values by Measure

Table 10-16: Lookup Values - Programmable Thermostat Measure

Measure Type	Building Area per Thermostat (sq.ft.)	Energy Savings (kWh/sq.ft.)	CF	Incremental Cost ($/ton)
Programmable Thermostats	1,264	2.12	0	204

10.2.9 HVAC Quality Installation

10.2.9.1 Applicability

Replace on Burnout and New Construction

10.2.9.2 Applicable Programs

This measure is applicable to APS' Solutions for Business programs, which include:

- Large Existing
- New Construction
- Small Business
- Schools

10.2.9.3 Measure Description

This HVAC measure promotes the quality installation of HVAC equipment and is split into two phases. Phase I includes sizing, testing and repair activities. Phase II involves sealing ducts based on the Phase I test results. This measure could apply to the replacing of an existing unit at the end of its useful life or the installation of a new unit in a new or existing building. The incentive is determined "per unit" basis, with additional incentives for Phase II based on the tonnage capacity of the unit.

10.2.9.4 Baseline Equipment Definition

Baseline definition for this measure is standard HVAC installation with no quality check.

10.2.9.5 Efficient Equipment Definition

Phase I

For system sizing, contractor to use Air Conditioning Contractors Association (ACCA) standard calculations and to provide documentation for:

- Manual N for load estimation
- Manual CS for system selection

For Refrigerant Charge and Air Flow (RCAF):

- Perform RCAG Testing
- Correct refrigerant charge and/or air flow to meet the criteria in Table 10-17.
- Supply all equipment pressures, sub cool and superheat readings, indoor (return) dry-bulb and wet-bulb, outdoor ambient temperature, indoor coil temperature split and duct static readings for return and supply duct.

Phase II

For ducts outside the thermal envelope with leakage >25 CFM per ton or ducts outside the thermal envelope with leakage >40CFM per ton:

- Seal ducts until leakage is below 25 CFM per ton. Leakage of up to 60 CFM per ton is allowed for major renovation projects where the ducts were not replaced.
- Measure duct leakage before and after sealing to verify that required leakage targets were met.

Table 10-17: RCAF Criteria

System Type	Criteria
Advanced Tune-up Testing Requirements	Outdoor temperature must be 55°F - 115°F for systems with R410A equipment. Outdoor temperature must be 60°F - 115°F for systems with R22 equipment. Indoor dry-bulb return air plenum must be between 70°F - 84°F during the test. Indoor wet-bulb (return) must be 50°F or higher during the test.
For Fixed Orifice Systems	+/- 5°F of Target Superheat + 3°F / -5°F of Target Temp Split
For systems with TXV	+/- 3°F of Target Sub cooling + 3°F / -5°F of Target Temp Split
All	Air flow 325 - 450 CFM per ton or + 3°F / -5°F of Target Temp Split between supply and return air

10.2.9.6 Unit Basis

This measure's savings and incremental measure cost are determined based on a "per unit" basis.

10.2.9.7 Effective Useful Life

This measure has an effective useful life of 10 years for Phase I and 15 years for Phase II determined from the DEER 2008.

10.2.9.8 Incremental Measure Cost

The incremental cost per ton for this measure varies depending on the unit type, unit size and includes the total material and labor costs. For details of specific incremental cost calculations, refer to the MAS.

10.2.9.9 Annual Energy Savings Algorithm

The following algorithm is used to estimate annual energy saving impacts per ton for this measure. Numeric values for the variables can be found in Table 10-18.

$$\Delta kWh = \frac{12}{EER_{ee}} \times ESF \times EFLH$$

Where:

ΔkWh	=	Energy savings for measure (in kWh)
EER_{ee}	=	Energy Efficiency Ratio for the efficient air-cooling unit (kW/ton)
ESF	=	Energy Savings Factor
EFLH	=	Effective Full Load Hours
12	=	EER to kW/ton conversion factor

10.2.9.10 Coincident Peak Demand Savings Algorithm

The following algorithm is used to estimate coincident peak demand saving impacts per ton for this measure. Numeric values for the variables can be found in Table 10-18.

$$\Delta kW_{Coincident} = \frac{12}{EER_{ee}} \times DSF \times CF$$

Where:

$\Delta kW_{Coincident}$	=	Coincident peak demand savings for this measure (in kW)
EER_{ee}	=	Energy Efficiency Ratio for the efficient air-cooling unit (kW/ton)
DSF	=	Demand Savings Factor
CF	=	Coincidence Factor
12	=	EER to kW/ton conversion factor

10.2.9.11 Algorithm Input Values by Measure

Table 10-18: Measure Lookup Values - HVAC Quality Installation

Measure Type	Average Size	EER_{ee}	DSF	ESF	EFLH	CF	Incremental Cost ($/ton)
Phase 1	12.4	9.46	7%	12%	1845	0.94	21
Phase 2	11.5	9.46	11%	11%	1845	0.94	40

10.2.10 HVAC System Testing and Repair

10.2.10.1 Applicability

Retrofit

10.2.10.2 Applicable Programs

This measure is applicable to APS' Solutions for Business programs, which include:

» Large Existing
» Small Business
» Schools

10.2.10.3 Measure Description

This HVAC measure promotes three different testing and repairing methods to be performed on existing (DX) packaged or split system cooling units. This measure consist of 1) Advanced Diagnostic Tune-up; 2) Economizer Repair; and 3) Duct Test & Repair and could apply on an existing unit. The incentive is determined "per unit" basis, with additional incentives for Duct Test and Repair based on the tonnage capacity of the unit.

Advanced Diagnostic Tune-up
Advanced Diagnostic Tune-up consists of an air conditioning equipment performance test-in with specialized program approved specialized test equipment, tune-up with repairs and a test-out. Refrigerant charge and air flow verification, belt replacement, air filters change, condenser coil cleaning with a non-acidic chemical, evaporator coil cleaning, cleaning condensate drain lines, electrical connections checked and tightened, economizer functional testing, and any repairs needed to bring the system back to the manufacturer's specifications.

Economizer Repair
Economizer repair is completed if economizer does not open or close under simulated cold or hot outdoor temperatures.

Duct Test & Repair
The Duct Testing & Repair measure uses diagnostic equipment to measure and repair duct leakage. The first step is to perform "Duct Leakage Test In" to determine total leakage. If system leakage is greater than 60 CFM per ton, seal ducts until leakage is below 60 CFM per ton or until leakage is reduced by

20% of total fan flow. Measure duct leakage (Test Out) after sealing or repairing duct system using same test procedure as the initial test to verify that the required leakage reduction is achieved.

10.2.10.4 Baseline Equipment Definition

Baseline equipment for "Advanced Diagnostic Tune-up" measure is 2 ton and up existing DX packaged or split systems with outdoor temperature 55°F or higher for systems with R410A refrigerant and 60°F or higher for systems with R22 refrigerant.

Baseline for "Economizer Repair" measure is malfunctioning economizer that does not open or close under simulated cold or hot outdoor temperatures.

Baseline for "Duct Test & Repair" measure is ducts located in the "unconditioned" space.

10.2.10.5 Efficient Equipment Definition

Efficient definition for "Advanced Diagnostic Tune-up" measure is the indoor return air plenum temperature is 70°F or higher at the end of the test cycle.

Efficient definition for "Economizer Repair" is economizer functioning properly under simulated cold or hot outdoor temperatures.

Efficient definition for "Duct Test & Repair" measure is ducts with 60 CFM per ton leakage or less.

10.2.10.6 Unit Basis

This measure's savings, and incremental measure cost are determined based on a "per unit" basis.

10.2.10.7 Effective Useful Life

This measure has an effective useful life of 5 years determined from the DEER 2008.

10.2.10.8 Incremental Measure Cost

The incremental cost per ton for this measure varies depending on the unit type, unit size, and economizer and includes the total material and labor costs. For details of specific incremental cost calculations, refer to the MAS.

10.2.10.9 Annual Energy Savings Algorithm

The following algorithm is used to estimate annual energy saving impacts per ton for this measure. Numeric values for the variables can be found in Table 10-19.

$$\Delta kWh = \frac{12}{EER_{ss}} \times ESF \times EFLH$$

Where:

ΔkWh	=	Energy savings for measure (in kWh)

EER_{ee}	=	Energy Efficiency Ratio for the efficient air-cooling unit (kW/ton)
ESF	=	Energy Savings Factor
EFLH	=	Effective Full Load Hours
12	=	EER to kW/ton conversion factor

10.2.10.10 Coincident Peak Demand Savings Algorithm

The following algorithm is used to estimate coincident peak demand saving impacts per ton for this measure. Numeric values for the variables can be found in Table 10-19.

$$\Delta kW_{CoincPeak} = \frac{12}{EER_{ee}} \times DSF \times CF$$

Where:

$\Delta kW_{CoincPeak}$	=	Coincident peak demand savings for measure (in kW)
EER_{ee}	=	Energy Efficiency Ratio for the efficient air-cooling unit (kW/ton)
DSF	=	Demand Savings Factor
CF	=	Coincidence Factor
12	=	EER to kW/ton conversion factor

10.2.10.11 Algorithm Input Values by Measure

Table 10-19: Measure Lookup Values - HVAC Test and Repair

Measure Type	Size Range (Tons)	Average Size	EER_{ee}	DSF	ESF	EFLH	CF	Incremental Cost ($/unit)
Advanced Diagnostic Tune Up (ADTU)	<6	4.60	8.93	7%	7%	1918	0.93	334
	6-10.9	7.95	8.93	7%	7%	1918	0.93	489
	11-19.9	14.63	8.93	7%	7%	1918	0.93	718
	20+	22.35	8.93	7%	7%	1918	0.93	977
Economizer (ECON)	<6	4.56	8.93	5%	5%	1918	0.93	113
	6-10.9	8.58	8.93	5%	5%	1918	0.93	150
	11-19.9	14.53	8.93	5%	5%	1918	0.93	188
	20+	22.35	8.93	5%	5%	1918	0.93	225
Duct Test and Repair (DTR)	<6	4.52	8.93	11%	11%	1918	0.93	1000
	6-10.9	7.74	8.93	11%	11%	1918	0.93	1327
	11-19.9	14.53	8.93	11%	11%	1918	0.93	1880
	20+	22.35	8.93	11%	11%	1918	0.93	2287

10.2.11 Western Cooling Control

10.2.11.1 Applicability

Retrofit

10.2.11.2 Applicable Programs

This measure is applicable to APS' Solutions for Business programs, which include:

- Large Existing
- New Construction
- Small Business
- Schools

10.2.11.3 Measure Description

Refer to Section 3.2.5 for a full description of this measure, savings algorithms, and impact estimates.

10.2.12 Smart Thermostats

10.2.12.1 Applicability

Retrofit

10.2.12.2 Applicable Programs

This measure is applicable to APS' Solutions for Business programs, which include:

» Large Existing
» New Construction
» Small Business
» Schools

10.2.12.3 Measure Description and Impact Algorithms

Refer to Section 2.3 for a full description of this measure and the algorithms used for impact estimates.

10.2.12.4 Algorithm Input Descriptions

This section presents the algorithm input descriptions that are used to estimate impacts for non-residential smart thermostats.

10.2.12.5 Unit Size

The HVAC unit the thermostat is assumed to be controlling is 4.7 tons per thermostat. This value is based typical unit size in APS territory for a small business, which is the most likely segment to deploy smart thermostats.

10.2.12.6 Unit Efficiency

The assumed efficiency of the HVAC unit is a SEER 13.0, EER 11.0 air conditioner. This is the typical efficiency of standard HVAC systems using recent federal standards.

10.2.12.7 Algorithm Input Values for Non-Residential Applications

Table 10-20 shows the savings factors for the energy and demand algorithms by measure. Table 10-21compares the average energy consumption, average coincident demand, and incremental cost between the various measures.

Table 10-20. Savings Factors for the Energy and Demand Algorithms by Measure Category

				Thermostat Model			
	Unit Size	Baseline HVAC Energy Use	Coincidence Factor	Nest, Honeywell, Ecobee	Other	EcoFactor, EnergyHub	Additional Smart Thermostat Features
Energy*	4.70	1266 kWh/ton	-	11.1%[10-13, 15, 16, 21]	7.5%	10.8%[9, 18, 19]	4.0%
Demand**	-	-	1.0	0.18 kW[13, 19]	0.18 kW[13, 19]	0.18 kW[13, 19]	0.067

* Energy savings are based on the various secondary sources available (see footnotes).
**Demand savings are based on the two secondary sources available (see footnotes).

Table 10-21: Energy Consumption, Coincident Demand, and Incremental Costs by Smart Thermostat Measure Type

Measure Type	Coincident Demand Savings (kW/unit)	Energy Savings (kWh/unit)	Incremental Cost ($/ton)
Smart Thermostat – Nest, Honeywell, Ecobee	0.18	661	150
Smart Thermostat – EcoFactor, Energy Hub	0.18	643	139
Smart Thermostat – Other Manufacturer	0.18	446	112
Additional Smart Thermostat Features (e.g. Nest's Seasonal Savings)[73]	0.07	238	85

10.2.13 Electronically Commutated Motors - HVAC

10.2.13.1 Applicability

Retrofit

10.2.13.2 Applicable Programs

This measure is applicable to APS' Solutions for Business programs, which include:

» Large Existing
» New Construction
» Small Business
» Schools

[73] These savings should be added to the savings from the smart thermostat if additional features are included in the installation.

10.2.13.3 Measure Description

This HVAC measure promotes the replacement of standard-efficiency shaded-pole fan motor in the existing HVAC unit (non-residential split or packaged AC unit) with ECM. The incentive is determined per motor basis.

10.2.13.4 Baseline Equipment Definition

The baseline case refers to a standard-efficiency shaded pole fan motor in the existing HVAC unit. The baseline parameters based on the HVAC unit size-range are provided in the Table 10-22.

Table 10-22: Baseline Equipment Efficiencies[74]

HVAC Unit Size-Range	$S/IEER_{base}$	EER_{base}	$HSPF_{base}$
≤ 65,000 Btu/h	13.0	11.15	7.7
65,000 – 135,000 Btu/h	11.2	11.0	11.3
135,000 – 240,000 Btu/h	10.8	10.8	10.9
≥ 240,000 Btu/h	10.1	10.5	10.9

10.2.13.5 Efficient Equipment Definition

The efficient case refers to a new ECM in an existing non-residential split or packaged AC unit.

10.2.13.6 Unit Basis

This measure's incentive, savings, and incremental measure cost are determined on a "per motor" basis.

10.2.13.7 Effective Useful Life

This measure has an effective useful life of 20 years determined from professional judgment.

10.2.13.8 Incremental Measure Cost

The incremental cost includes the total material and labor costs, which are based on interviews with industry experts and secondary sources. The incremental cost can be found in the Table 10-23.

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[74] Baseline S/IEER values were derived from reviewing the lowest common efficiencies of "Active" units in the AHRI database for each size category and comparing with manufacturer data
Baseline HSPF derived from COP sourced EERE Appliance Standards
(http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/77)

10.2.13.9 Annual Energy Savings Algorithm

The following algorithm is used to estimate annual energy saving impacts for this measure. Numeric values for the variables can be found in the Table 10-23.

$$\Delta kWh = \left[\left(\frac{1}{IEER_{base}} - \frac{1}{IEER_{ee}}\right) \times EFLH_{cooling} + 0.5 \times \left(\frac{1}{HSPF_{base}} - \frac{1}{HSPF_{ee}}\right) \times EFLH_{heating}\right] * kBtuh/motor$$

Where:

ΔkWh	=	Energy savings for measure per motor (in kWh)
$IEER_{base}$	=	Efficiency of the baseline HVAC unit
$IEER_{ee}$	=	Efficiency of the efficient HVAC unit
$HSPF_{base}$	=	Heating Seasonal Performance Factor
$HSPF_{ee}$	=	Heating Seasonal Performance Factor
$EFLH_{cooling}$	=	Cooling Effective Full Load Hours
$EFLH_{heating}$	=	Heating Effective Full Load Hours
0.5	=	Proportion of heat pumps
kBtuh/ motor	=	Cooling capacity of each motor, based on Navigant's research. This value is provided in the Table 10-23.

10.2.13.10 Coincident Peak Demand Savings Algorithm

The following algorithm is used to estimate annual coincident peak demand saving impacts for this measure. Numeric values for the variables can be found in the Table 10-23.

$$\Delta kW_{Coincident} = \left[\left(\frac{1}{EER_{base}} - \frac{1}{EER_{ee}}\right) \times LF \times CF\right] * kBtuh/motor$$

Where:

$\Delta kW_{coincident}$	=	Coincident peak demand savings per motor for this measure
EER_{base}	=	Efficiency of the baseline equipment
EER_{ee}	=	Efficiency of the efficient equipment
CF	=	Coincidence Factor = 0.9
LF	=	Load Factor = 1.0
kBtuh/ motor	=	Cooling capacity of each motor, based on Navigant's research. This value is provided in the Table 10-23.

10.2.13.11 Algorithm Input Values by Measure

The values presented in the following table are based on secondary research and historical participation data for the Solutions for Business Program.

Table 10-23. Measure Lookup Values – EC Motors Installed on HVAC Systems

Measure Size	Tier	$IEER_{ee}$	EER_{ee}	$HSPF_{ee}$	$EFLH_{cooling}$	$EFLH_{heating}$	kBtuh / motor	Incremental Cost ($/kBtu/h)
<65kBtu/h	1	14.5	11.8	8.5	2497	227	29.7	511.2
65-135kBtu/h	0	12.7	11.6	11.6	2497	227	54.3	511.9
135-240kBtu/h	0	12.3	11.6	10.9	2497	227	60.7	515.6
≥240kBtu/h	0	11.6	10.5	10.9	2497	227	76.4	560.7

The values for energy, non-coincident demand, and coincident demand impacts are shown in Table 10-24.

Table 10-24. Energy and Demand Impacts for EC Motors Installed on HVAC Systems

Measure Size	Annual Energy Savings (kWh per motor)	Annual Non-Coincident Demand Savings (kW per motor)	Annual Coincident Demand Savings (kW per motor)
<65kBtu/h	631	0.15	0.13
65-135kBtu/h	1,445	0.26	0.23
135-240kBtu/h	1,710	0.39	0.35
≥240kBtu/h	2,441	0.52	0.47
Weighted Average	1,557	0.33	0.29

11. SOLUTIONS FOR BUSINESS – MOTORS

11.1 Algorithm Inputs

11.1.1 Hours of Operation

Annual hours of operation for different measure types are derived from a combination of data from the U.S. Department of Energy's (DOE) Benchmark Prototype Models[75], the EUDAP conducted by APS and the Green Motors Practices Group[76]. Variations within measures are due to different operating conditions for different buildings.

11.1.2 Horsepower (HP)

HP is the rated horsepower of the energy efficient motor. For constant speed and uniformly loaded motors, the prescriptive measurement and verification protocols described below apply for replacement of old motors with new energy efficient motors of the same rated horsepower. Horsepower values used in estimating savings are derived from program implementation tracking data and on-site verification.

11.1.3 HP to kWh Conversion Factor

0.746 is the conversion factor between HP and kWh.

11.1.4 Baseline Full Load Efficiency - ODP and TEFC (η_{base})

The η_{base} is the efficiency of the baseline motor. Efficiencies are based on NEMA premium efficiency motor standards (see Table 11-1).

11.1.5 Efficient Full Load Efficiency - ODP and TEFC (η_{ee})

The η_{ee} is the efficiency of the efficient motor. Efficiencies are based on nameplate data (see Table 11-2) derived from program implementation tracking data and on-site verification.

11.1.6 Baseline Full Load Efficiency - Green Motor Rewind (η_{rewind})

The η_{rewind} is the efficiency of the baseline motor. Efficiencies are based on the standard rewind efficiencies.

11.1.7 Efficient Full Load Efficiency - Green Motor Rewind Applications ($\eta_{average}$)

The $\eta_{average}$ is the efficiency of the efficient motor. Efficiencies are based on the average of NEMA premium efficiencies for each size of motors at different RPMs.

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[75] http://www.energycodes.gov/development/commercial/90.1_models

[76] "Quality Motor Rewinding an Energy Efficiency Measure" established by the Green Motors Practices Group (GMPG)

11.1.8 Nominal Full Load Efficiency - VSD Applications (η_{motor})

The η_{motor} is the efficiency of the motor at the full-rated load. This can be either an energy efficient motor or standard efficiency motor.

11.1.9 Load Factor (LF)

The LF is the ratio between the actual load and the rated load. Values for load factor are based on review of typical sizing calculations for commercial and industrial motor applications.

11.1.10 Coincidence Factor (CF)

The CF is the fraction of the peak demand of a population that is in operation at the time of APS' system peak. Values for coincidence factor are based on review of typical load profiles for commercial and industrial motor applications.

11.1.11 Demand Savings Factor (DSF)

The DSF represents the percent savings over baseline energy demand. This value is based on a review of typical load shapes for commercial and industrial motor applications. The savings factor is based on fan/pump affinity laws that show motor power is proportional to the cube of motor speed.

11.1.12 Energy Savings Factor (ESF)

The ESF represents the percent savings over baseline energy consumption. This value is based on a review of typical load shapes for commercial and industrial motor applications. The savings factor is based on fan/pump affinity laws that show motor power is proportional to the cube of motor speed.

11.2 Measure Characterization

11.2.1 Open Drip-Proof (ODP) and Totally Enclosed Fan-Cooled (TEFC) Motors

11.2.1.1 Applicability

Replace on Burnout and New Construction

11.2.1.2 Applicable Programs

This measure is applicable to APS' Solutions for Business programs, which include:

- Large Existing
- New Construction
- Small Business
- Schools

11.2.1.3 Measure Description

This motor measure promotes the replacement of existing motors with three-phase induction motors of open drip-proof (open) and totally enclosed fan-cooled (closed) classifications. It is recommended to consider matching water or air flows (GPM, CFM) of the existing pump or fan when installing energy efficient motors that inherently have higher speeds (less slip) to increase energy savings. The measure incentives are based on the motor's Nominal Full Load Efficiencies that exceed the efficiency standards based on the Table 11-1.

Table 11-1: Baseline Premium Motor Nominal Efficiencies

Size HP	Open Drip Proof (ODP) Speed (RPM)			Totally Enclosed Fan Cooled (TEFC) Speed (RPM)		
	1200	1800	3600	1200	1800	3600
1	82.50%	85.50%	77.00%	82.50%	85.50%	77.00%
1.5	86.50%	86.50%	84.00%	87.50%	86.50%	84.00%
2	87.50%	86.50%	85.50%	88.50%	86.50%	85.50%
3	88.50%	89.50%	85.50%	89.50%	89.50%	86.50%
5	89.50%	89.50%	86.50%	89.50%	89.50%	88.50%
7.5	90.20%	91.00%	88.50%	91.00%	91.70%	89.50%
10	91.70%	91.70%	89.50%	91.00%	91.70%	90.20%
15	91.70%	93.00%	90.20%	91.70%	92.40%	91.00%
20	92.40%	93.00%	91.00%	91.70%	93.00%	91.00%
25	93.00%	93.60%	91.70%	93.00%	93.60%	91.70%
30	93.60%	94.10%	91.70%	93.00%	93.60%	91.70%
40	94.10%	94.10%	92.40%	94.10%	94.10%	92.40%
50	94.10%	94.50%	93.00%	94.10%	94.50%	93.00%
60	94.50%	95.00%	93.60%	94.50%	95.00%	93.60%
75	94.50%	95.00%	93.60%	94.50%	95.40%	93.60%
100	95.00%	95.40%	93.60%	95.00%	95.40%	94.10%
125	95.00%	95.40%	94.10%	95.00%	95.40%	95.00%
150	95.40%	95.80%	94.10%	95.80%	95.80%	95.00%
≥200	95.40%	95.80%	95.00%	95.80%	96.20%	95.40%

Source: NEMA Premium Efficiency Motor Standards

11.2.1.4 Baseline Equipment Definition

The baseline equipment assumes motors that meet the minimum efficiency allowed under the Energy Independence and Security Act of 2007 (EISA). EISA requires that general purpose motors (subtype I) from 1 to 200HP, inclusive, shall have a nominal full-load efficiency that is not less than as defined in NEMA premium efficiency standards, refer to the Table 11-1.

11.2.1.5 Efficient Equipment Definition

The efficient equipment refers to three-phase induction motors of open drip-proof (ODP) and totally enclosed fan-cooled (TEFC) classifications. Efficiencies must exceed NEMA premium efficiency standards and are based on program implementation tracking data.

11.2.1.6 Unit Basis

This measure's savings, and incremental measure cost are determined based on a "per HP" basis.

11.2.1.7 Effective Useful Life

This measure has an effective useful life of 15 years determined from DEER 2008[77].

11.2.1.8 Incremental Measure Cost

The incremental cost per HP for this measure varies depending on the motor type, motor HP, and motor rpm and includes the total material. Incremental costs are based on manufacturer and retail data. For details of specific incremental cost calculations, refer to the MAS.

11.2.1.9 Annual Energy Savings Algorithm

The following algorithm is used to estimate annual energy saving impacts for this measure. Numeric values for the variables can be found in Table 11-2.

$$\Delta kWh = 0.746 \times \left(\frac{1}{\eta_{base}} - \frac{1}{\eta_{ee}}\right) \times LF \times OpHrs$$

Where:

ΔkWh	=	Energy savings for measure (in kWh)
0.746	=	HP to kWh conversion factor
η_{base}	=	Nominal Full Load Efficiency of Baseline Motor
η_{ee}	=	Nominal Full Load Efficiency of Efficient Motor
LF	=	Load Factor
OpHrs	=	Hours of operation

11.2.1.10 Coincident Peak Demand Savings Algorithm

The following algorithm is used to estimate coincident peak demand saving impacts for this measure. Numeric values for the variables can be found in Table 11-2.

$$\Delta kW_{CoincMax} = 0.746 \times \left(\frac{1}{\eta_{base}} - \frac{1}{\eta_{ee}}\right) \times LF \times CF$$

[77] http://www.deeresources.com/

Where:

$\Delta kW_{coincident}$	=	Coincident peak demand savings for this measure (in kW)
0.746	=	HP to kWh conversion factor
η_{base}	=	Nominal Full Load Efficiency of Baseline Motor
η_{ee}	=	Nominal Full Load Efficiency of Efficient Motor
LF	=	Load Factor
CF	=	Coincidence Factor

11.2.1.11 Algorithm Input Values by Measure

For baseline values, refer to Table 11-1.

Table 11-2: Lookup Values - Efficient Motors Measure

Measure Sub-category	Measure	HP	Nominal Full Load Efficiency	EFLH	LF	CF	Incremental Cost ($/HP)
Open Drip Proof (ODP)	1800 RPM	1	86.0%	5384	0.80	0.95	3.74
ODP	1800 RPM	1.5	87.0%	5384	0.80	0.95	2.81
ODP	1800 RPM	2	87.0%	5384	0.80	0.95	2.35
ODP	1800 RPM	3	90.0%	5384	0.80	0.95	1.90
ODP	1800 RPM	5	90.0%	5384	0.80	0.95	1.55
ODP	1800 RPM	7.5	91.5%	5384	0.80	0.95	1.40
ODP	1800 RPM	10	92.2%	5384	0.80	0.95	1.33
ODP	1800 RPM	15	93.5%	5384	0.80	0.95	1.27
ODP	1800 RPM	20	93.5%	5384	0.80	0.95	1.25
ODP	1800 RPM	25	94.1%	5384	0.80	0.95	1.24
ODP	1800 RPM	30	94.6%	5384	0.80	0.95	1.24
ODP	1800 RPM	40	94.6%	5384	0.80	0.95	1.23
ODP	1800 RPM	50	95.0%	5384	0.80	0.95	1.23
ODP	1800 RPM	60	95.5%	5384	0.80	0.95	1.23
ODP	1800 RPM	75	95.5%	5384	0.80	0.95	1.24
ODP	1800 RPM	100	95.9%	5384	0.80	0.95	1.24
ODP	1800 RPM	125	95.9%	5384	0.80	0.95	1.24

ODP	1800 RPM	150	96.3%	5384	0.80	0.95	1.24
ODP	1800 RPM	150+	96.3%	5384	0.80	0.95	1.24
ODP	1200 RPM	1	83.0%	5384	0.80	0.95	1.89
ODP	1200 RPM	1.5	87.0%	5384	0.80	0.95	1.69
ODP	1200 RPM	2	88.0%	5384	0.80	0.95	1.62
ODP	1200 RPM	3	89.0%	5384	0.80	0.95	1.60
ODP	1200 RPM	5	90.0%	5384	0.80	0.95	1.67
ODP	1200 RPM	7.5	90.7%	5384	0.80	0.95	1.79
ODP	1200 RPM	10	92.2%	5384	0.80	0.95	1.89
ODP	1200 RPM	15	92.2%	5384	0.80	0.95	2.06
ODP	1200 RPM	20	92.9%	5384	0.80	0.95	2.19
ODP	1200 RPM	25	93.5%	5384	0.80	0.95	2.28
ODP	1200 RPM	30	94.1%	5384	0.80	0.95	2.35
ODP	1200 RPM	40	94.6%	5384	0.80	0.95	2.46
ODP	1200 RPM	50	94.6%	5384	0.80	0.95	2.53
ODP	1200 RPM	60	95.0%	5384	0.80	0.95	2.58
ODP	1200 RPM	75	95.0%	5384	0.80	0.95	2.64
ODP	1200 RPM	100	95.5%	5384	0.80	0.95	2.70
ODP	1200 RPM	125	95.5%	5384	0.80	0.95	2.74
ODP	1200 RPM	150	95.9%	5384	0.80	0.95	2.77
ODP	1200 RPM	150+	95.9%	5384	0.80	0.95	2.80
ODP	3600 RPM	1.5	84.5%	5384	0.80	0.95	4.30
ODP	3600 RPM	2	86.0%	5384	0.80	0.95	3.25
ODP	3600 RPM	3	86.0%	5384	0.80	0.95	2.73
ODP	3600 RPM	5	87.0%	5384	0.80	0.95	2.22
ODP	3600 RPM	7.5	89.0%	5384	0.80	0.95	1.84
ODP	3600 RPM	10	90.0%	5384	0.80	0.95	1.67
ODP	3600 RPM	15	90.7%	5384	0.80	0.95	1.60
ODP	3600 RPM	20	91.5%	5384	0.80	0.95	1.55
ODP	3600 RPM	25	92.2%	5384	0.80	0.95	1.53
ODP	3600 RPM	30	92.2%	5384	0.80	0.95	1.53

ODP	3600 RPM	40	92.9%	5384	0.80	0.95	1.53
ODP	3600 RPM	50	93.5%	5384	0.80	0.95	1.53
ODP	3600 RPM	60	94.1%	5384	0.80	0.95	1.54
ODP	3600 RPM	75	94.1%	5384	0.80	0.95	1.54
ODP	3600 RPM	100	94.1%	5384	0.80	0.95	1.55
ODP	3600 RPM	125	94.6%	5384	0.80	0.95	1.55
ODP	3600 RPM	150	94.6%	5384	0.80	0.95	1.56
ODP	3600 RPM	150+	95.5%	5384	0.80	0.95	1.56
Totally Enclosed Fan Cooled (TEFC)	1800 RPM	1	86.0%	5384	0.80	0.95	8.92
TEFC	1800 RPM	1.5	87.0%	5384	0.80	0.95	8.69
TEFC	1800 RPM	2	87.0%	5384	0.80	0.95	8.47
TEFC	1800 RPM	3	90.0%	5384	0.80	0.95	8.05
TEFC	1800 RPM	5	90.0%	5384	0.80	0.95	7.40
TEFC	1800 RPM	7.5	92.2%	5384	0.80	0.95	6.33
TEFC	1800 RPM	10	92.2%	5384	0.80	0.95	5.79
TEFC	1800 RPM	15	92.9%	5384	0.80	0.95	5.26
TEFC	1800 RPM	20	93.5%	5384	0.80	0.95	4.99
TEFC	1800 RPM	25	94.1%	5384	0.80	0.95	4.83
TEFC	1800 RPM	30	94.1%	5384	0.80	0.95	4.73
TEFC	1800 RPM	40	94.6%	5384	0.80	0.95	4.59
TEFC	1800 RPM	50	95.0%	5384	0.80	0.95	4.51
TEFC	1800 RPM	60	95.5%	5384	0.80	0.95	4.46
TEFC	1800 RPM	75	95.9%	5384	0.80	0.95	4.41
TEFC	1800 RPM	100	95.9%	5384	0.80	0.95	4.35
TEFC	1800 RPM	125	95.9%	5384	0.80	0.95	4.32
TEFC	1800 RPM	150	96.3%	5384	0.80	0.95	4.30
TEFC	1800 RPM	150+	96.7%	5384	0.80	0.95	4.27
TEFC	1200 RPM	1	83.0%	5384	0.80	0.95	10.25
TEFC	1200 RPM	1.5	88.0%	5384	0.80	0.95	10.09
TEFC	1200 RPM	2	89.0%	5384	0.80	0.95	9.93

TEFC	1200 RPM	3	90.0%	5384	0.80	0.95	9.63
TEFC	1200 RPM	5	90.0%	5384	0.80	0.95	9.05
TEFC	1200 RPM	7.5	91.5%	5384	0.80	0.95	8.53
TEFC	1200 RPM	10	91.5%	5384	0.80	0.95	7.68
TEFC	1200 RPM	15	92.2%	5384	0.80	0.95	6.79
TEFC	1200 RPM	20	92.2%	5384	0.80	0.95	6.33
TEFC	1200 RPM	25	93.5%	5384	0.80	0.95	6.04
TEFC	1200 RPM	30	93.5%	5384	0.80	0.95	5.85
TEFC	1200 RPM	40	94.6%	5384	0.80	0.95	5.59
TEFC	1200 RPM	50	94.6%	5384	0.80	0.95	5.44
TEFC	1200 RPM	60	95.0%	5384	0.80	0.95	5.33
TEFC	1200 RPM	75	95.0%	5384	0.80	0.95	5.22
TEFC	1200 RPM	100	95.5%	5384	0.80	0.95	5.11
TEFC	1200 RPM	125	95.5%	5384	0.80	0.95	5.04
TEFC	1200 RPM	150	96.3%	5384	0.80	0.95	4.99
TEFC	1200 RPM	150+	96.3%	5384	0.80	0.95	4.93
TEFC	3600 RPM	1.5	84.5%	5384	0.80	0.95	7.08
TEFC	3600 RPM	2	86.0%	5384	0.80	0.95	6.07
TEFC	3600 RPM	3	87.0%	5384	0.80	0.95	5.12
TEFC	3600 RPM	5	89.0%	5384	0.80	0.95	4.46
TEFC	3600 RPM	7.5	90.0%	5384	0.80	0.95	4.23
TEFC	3600 RPM	10	90.7%	5384	0.80	0.95	4.16
TEFC	3600 RPM	15	91.5%	5384	0.80	0.95	4.17
TEFC	3600 RPM	20	91.5%	5384	0.80	0.95	4.22
TEFC	3600 RPM	25	92.2%	5384	0.80	0.95	4.27
TEFC	3600 RPM	30	92.2%	5384	0.80	0.95	4.32
TEFC	3600 RPM	40	92.9%	5384	0.80	0.95	4.39
TEFC	3600 RPM	50	93.5%	5384	0.80	0.95	4.45
TEFC	3600 RPM	60	94.1%	5384	0.80	0.95	4.49
TEFC	3600 RPM	75	94.1%	5384	0.80	0.95	4.54
TEFC	3600 RPM	100	94.6%	5384	0.80	0.95	4.59

TEFC	3600 RPM	125	95.5%	5384	0.80	0.95	4.62
TEFC	3600 RPM	150	95.5%	5384	0.80	0.95	4.65
TEFC	3600 RPM	150+	95.9%	5384	0.80	0.95	4.68

11.2.2 Green Motor Rewind

11.2.2.1 Applicability

Retrofit

11.2.2.2 Applicable Programs

This measure is applicable to APS' Solutions for Business programs, which include:

- Large Existing
- Small Business
- Schools

11.2.2.3 Measure Description

This motor measure promotes efficient practices for rewinding of failed motors to achieve the original nameplate efficiency without replacing it.

11.2.2.4 Baseline Equipment Definition

The baseline equipment assumes standard rewind values are 0.5-0.7% less than the original nameplate efficiencies based on review of motor rewind studies.

11.2.2.5 Efficient Equipment Definition

The efficient equipment is defined as the original nameplate efficiency of the rewound motor.

11.2.2.6 Unit Basis

This measure's savings and incremental measure costs are determined based on a "per HP" basis.

11.2.2.7 Effective Useful Life

This measure has an effective useful life of 5 years determined from DEER 2008[78] and de-rated by 5 years to account for age of motor.

[78] http://www.deeresources.com/

11.2.2.8 Incremental Measure Cost

The incremental cost per HP for this measure are based on secondary sources and varies depending on the motor type, motor HP, and motor rpm and includes the total material and labor costs. For details of specific incremental cost calculations, refer to the MAS.

11.2.2.9 Annual Energy Savings Algorithm

The following algorithm is used to estimate annual energy saving impacts for this measure. Numeric values for the variables can be found in Table 11-3.

$$\Delta kWh = 0.746 \times \left(\frac{1}{\eta_{rewind}} - \frac{1}{\eta_{average}}\right) \times LF \times EFLH$$

Where:

ΔkWh	=	Energy savings for measure (in kWh)
0.746	=	HP to kWh conversion factor
η_{rewind}	=	Standard rewind efficiency
$\eta_{average}$	=	Average of NEMA premium motor efficiencies
LF	=	Load Factor
EFLH	=	Equivalent Full Load Hours

11.2.2.10 Coincident Peak Demand Savings Algorithm

The following algorithm is used to estimate coincident peak demand saving impacts for this measure. Numeric values for the variables can be found in Table 11-3.

$$\Delta kW_{coincident} = 0.746 \times \left(\frac{1}{\eta_{rewind}} - \frac{1}{\eta_{average}}\right) \times LF \times CF$$

Where:

$\Delta kW_{coincident}$	=	Coincident peak demand savings for this measure (in kW)
0.746	=	HP to kWh conversion factor
η_{rewind}	=	Standard rewind efficiency
$\eta_{average}$	=	Average of NEMA premium motor efficiencies
LF	=	Load Factor
CF	=	Coincidence Factor

11.2.2.11 Algorithm Input Values by Measure

Table 11-3: Measure Lookup Values - Green Motor Rewind

Measure Sub-category	HP	Average Efficiency	Standard Rewind Derate	Standard Rewind Efficiency	EFLH	LF	CF	Incremental Cost ($/HP)
Motor Rewind	50	93.3%	0.7%	92.6%	4067	0.68	0.95	3.05
Motor Rewind	60	93.9%	0.6%	93.3%	5329	0.68	0.95	3.05
Motor Rewind	75	94.0%	0.5%	93.5%	5329	0.68	0.95	3.05
Motor Rewind	100	94.3%	0.5%	93.8%	5329	0.68	0.95	3.05
Motor Rewind	125	94.6%	0.5%	94.1%	5200	0.68	0.95	3.05
Motor Rewind	150	95.0%	0.5%	94.5%	5200	0.68	0.95	3.05
Motor Rewind	200	95.2%	0.5%	94.7%	5200	0.68	0.95	3.05
Motor Rewind	300	95.3%	0.5%	94.8%	7186	0.68	0.95	3.05
Motor Rewind	400	95.5%	0.5%	95.0%	7186	0.68	0.95	3.05
Motor Rewind	500	95.7%	0.5%	95.2%	7186	0.68	0.95	3.05
Motor Rewind	600	95.9%	0.5%	95.4%	7186	0.68	0.95	3.05
Motor Rewind	700	96.0%	0.5%	95.5%	7186	0.68	0.95	3.05
Motor Rewind	800	96.1%	0.5%	95.6%	7186	0.68	0.95	3.05
Motor Rewind	900	96.4%	0.5%	95.9%	7186	0.68	0.95	3.05
Motor Rewind	1000	96.5%	0.5%	96.0%	7186	0.68	0.95	3.05

11.2.3 Variable Speed Drives (VSD)

11.2.3.1 Applicability

Retrofit and New Construction

11.2.3.2 Applicable Programs

This measure is applicable to APS' Solutions for Business programs, which include:

- Large Existing
- New Construction
- Small Business
- Schools

11.2.3.3 Measure Description

This measure promotes the installation of VSDs on existing motors to reduce energy use by regulating the motor speed to match required loads. Large amounts of energy savings are probable with small reductions in the motor speed due to the non-linear relationship between speed and power based on affinity laws.

11.2.3.4 Baseline Equipment Definition

The baseline equipment assumes motors with constant speeds and with no existing VSDs.

11.2.3.5 Efficient Equipment Definition

The efficient equipment refers to motors with VSDs and with permanently removed or disabled any throttling devices such as inlet vanes, bypass dampers, or throttling valves.

11.2.3.6 Unit Basis

This measure's incentive, savings, and incremental measure cost are determined on a "per HP" basis.

11.2.3.7 Effective Useful Life

This measure has an effective useful life of 15 years determined from DEER 2008[79].

11.2.3.8 Incremental Measure Cost

The incremental cost per HP for this measure varies depending on the motor type, motor HP, and motor rpm and includes the total material and labor costs determined from APS project invoices and the DEER 2008. For details of specific incremental cost calculations, refer to the MAS.

11.2.3.9 Annual Energy Savings Algorithm

Energy savings and VSD hours of operation are based on metering data for a wide range of VSD application types. The savings are based on the difference between metered consumption and the assumed baseline of a motor running at full capacity during corresponding times. Impact estimates are shown in Table 11-4.

11.2.3.10 Coincident Peak Demand Savings Algorithm

Coincident demand savings are based on metering data for a wide range of VSD application types. The savings are based on the difference between metered consumption and the assumed baseline of a motor running at full capacity during corresponding times. Impact estimates are shown in Table 11-4.

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[79] http://www.deeresources.com/

11.2.3.11 VSD Energy and Demand Savings by Application Type

Table 11-4 presents the non-coincident demand savings, coincident demand savings, and annual energy savings per horsepower (hp), for various VSD applications.

Table 11-4: Measure Impact Values – VSD

VSD Application	Non-Coincident Demand Savings (kW/hp)	Coincident Demand Savings (kW/hp)	Annual Energy Savings (kWh/hp)
Chilled Water Pump	0.3579	0.3400	2228
Condenser Water Pump	0.3653	0.3470	1458
Domestic Water Pump	0.1653	0.1570	1228
HVAC Fan	0.3979	0.3780	2309
Cooling Tower Fan	0.4821	0.4580	523
Chiller Compressor	0.0600	0.0570	772
Process Motor	0.1947	0.1850	966
Air Compressor	0.1947	0.1850	2209
Refrigeration Compressor	0.1947	0.1850	927
Refrigeration Fan	0.1947	0.1850	1807
Pool Pumps***	0.1458	0.1458	3630
Other/Misc	0.1947	0.1850	1477
Weighted Average	0.2063	0.1960	1350

12. SOLUTIONS FOR BUSINESS - REFRIGERATION

12.1 Algorithm Inputs

12.1.1 Hours of Operation (OpHrs)

Annual hours of operation for different measure types vary depending on the equipment's application. Values are based on engineering models and secondary literature reviews specific to commercial refrigeration equipment.

12.1.2 Demand Interaction Factor (DIF)

The demand interaction factor is used to account for the fraction of the direct measure demand savings that decrease (or increase) cooling load of a refrigerated system. Demand interaction factors for relevant measure types were determined from engineering analysis.

12.1.3 Energy Interaction Factor (EIF)

The energy interaction factor is used to account for the fraction of the direct measure energy savings that decrease (or increase) cooling consumption of a refrigerated system. Energy interaction factors for relevant measure types were determined from engineering analysis.

12.1.4 Coincidence Factor (CF)

The CF is the fraction of the peak demand of a population that is in operation at the time of APS' system peak and is derived from engineering analysis or secondary literature review.

12.1.5 Load Factor (LF)

The LF is the ratio of the actual load that a compressor or motor to the rated load of the equipment based on nameplate power/capacity.

12.1.6 Demand Savings Factor (DSF)

The DSF represents the percent savings over baseline energy demand. Values are based on engineering models and secondary literature reviews specific to commercial refrigeration equipment.

12.1.7 Energy Savings Factor (ESF)

The ESF represents the percent savings over baseline energy consumption. Values are based on engineering models and secondary literature reviews specific to commercial refrigeration equipment.

12.1.8 Base Energy Consumption

Base energy consumption reflects annual energy consumption from baseline equipment before the installation of controls or replacement with more efficient equipment. Depending on the specific measure, this value may be applied on a different unit basis (e.g., kWh per LF, kWh per ton). Values are based on engineering models and secondary literature reviews specific to commercial refrigeration equipment.

12.1.9 Base Demand

Base demand reflects the highest load from baseline equipment before the installation of controls or replacement with more efficient equipment. Depending on the specific measure, this value may be applied on a different unit basis (e.g., kW per unit, kBtuh per LF). Values are based on engineering models and secondary literature reviews specific to commercial refrigeration equipment.

12.1.10 Base COP

The Base coefficient of performance (COP) refers to the efficiency for the baseline condition of a commercial refrigeration system.

12.1.11 EE COP

The EE coefficient of performance (COP) refers to the efficiency for the efficient condition of a commercial refrigeration system.

12.1.12 Duty Cycle (DC)

The duty cycle refers to the percent of time a compressor operates to meet the required cooling load. Values are based on engineering models and secondary literature reviews specific to commercial refrigeration equipment.

12.2 Measure Characterization

12.2.1 Anti-Sweat Heater Controls

12.2.1.1 Applicability

Retrofit

12.2.1.2 Applicable Programs

This measure is applicable to APS' Solutions for Business programs, which include:

- Large Existing
- New Construction
- Small Business
- Schools

12.2.1.3 Measure Description

This refrigeration end-use measure promotes the installation of devices that sense the relative humidity in the air outside of the display case, reduce or turn off the glass door (if applicable), and frame anti-sweat heaters at low-humidity conditions.

12.2.1.4 Baseline Equipment Definition

The baseline case refers to a refrigerated display case that does not have anti-sweat heater controls.

12.2.1.5 Efficient Equipment Definition

The efficient case refers to a refrigerated display case that has anti-sweat heater controls.

12.2.1.6 Unit Basis

This measure's incentive, savings, and incremental measure cost are determined on a "per linear foot" basis for refrigerated display cases.

12.2.1.7 Effective Useful Life

This measure has an effective useful life of 12 years determined from DEER 2008[80].

12.2.1.8 Incremental Measure Cost

The incremental cost for this measure includes the total material and labor costs. Incremental costs are based on interviews with industry experts and secondary sources. Specific incremental costs can be found in Table 12-1.

12.2.1.9 Annual Energy Savings Algorithm

The following algorithm is used to estimate annual energy saving impacts for this measure. Numeric values for the variables can be found in Table 12-1.

$$\Delta kWh = kWh_{base} \times ESF \times (1 + EIF)$$

Where:

ΔkWh	=	Energy savings for measure (in kWh/LF)
kWh_{base}	=	Baseline Energy Usage per LF
ESF	=	Energy Savings Factor
EIF	=	Energy Interaction Factor

12.2.1.10 Coincident Peak Demand Savings Algorithm

The following algorithm is used to estimate annual coincident peak demand saving impacts for this measure. Numeric values for the variables can be found in Table 12-1.

$$\Delta kW_{Coincident} = \frac{kWh_{base} \times ESF \times CF}{8760}$$

Where:

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80 http://www.deeresources.com/

$\Delta kW_{coincident}$	=	Coincident peak demand savings for this measure (in kW/LF)
kWh_{base}	=	Baseline Energy Usage per LF
DSF	=	Demand Savings Factor
EIF	=	Energy Interaction Factor
CF	=	Coincidence Factor

12.2.1.11 Algorithm Input Values by Measure

Table 12-1. Measure Lookup Values - Anti-Sweat Heater Controls

Measure	kWh_{base}	DSF	ESF	CF	EIF	Incremental Cost ($/LF)
Anti-Sweat Heater Controls	373.3	0.15	0.61	1	0.24	$35.94

12.2.2 High-Efficiency Evaporator Fan Motors

12.2.2.1 Applicability

Retrofit

12.2.2.2 Applicable Programs

This measure is applicable to APS' Solutions for Business programs, which include:

» Large Existing
» New Construction
» Small Business
» Schools

12.2.2.3 Measure Description

This refrigeration end-use measure promotes the replacement of standard shaded-pole evaporator fan motor in refrigerated display cases or fan coil in walk-ins with an electronically commuted motor (ECM) or a permanent split-capacitor (PSC) motor.

12.2.2.4 Baseline Equipment Definition

The baseline case refers to a refrigerated display case with a standard-efficiency shaded-pole evaporator fan or fan coil with walk-ins.

12.2.2.5 Efficient Equipment Definition

The efficient case refers to a refrigerated display case with an ECM or PSC motor.

12.2.2.6 Unit Basis

This measure's incentive, savings, and incremental measure cost are determined on a "per motor" basis.

NAVIGANT

12.2.2.7 Effective Useful Life

This measure has an effective useful life of 15 years determined from the DEER 2008[81].

12.2.2.8 Incremental Measure Cost

The incremental cost for this measure varies depending on the fan motor type and includes the total material and labor costs. Incremental costs are based on interviews with industry experts and secondary sources. Specific incremental costs for different motor types can be found in Table 12-2.

12.2.2.9 Annual Energy Savings Algorithm

The following algorithm is used to estimate annual energy saving impacts for this measure. Numeric values for the variables can be found in Table 12-2.

$$\Delta kWh = kW_{base} \times ESF \times OpHrs \times (1 + EIF)$$

Where:

ΔkWh	=	Energy savings for measure (in kWh/LF)
kW_{base}	=	Baseline Demand
ESF	=	Energy Savings Factor
OpHrs	=	Operating Hours
EIF	=	Energy Interaction Factor

12.2.2.10 Coincident Peak Demand Savings Algorithm

The following algorithm is used to estimate annual coincident peak demand saving impacts for this measure. Numeric values for the variables can be found in Table 12-2.

$$\Delta kW_{coincident} = kW_{base} \times DSF \times (1 + DIF) \times CF$$

Where:

$\Delta kW_{coincident}$	=	Coincident peak demand savings for this measure (in kW/LF)
kW_{base}	=	Baseline Demand
DSF	=	Demand Savings Factor
DIF	=	Demand Interaction Factor
CF	=	Coincidence Factor

[81] http://www.deeresources.com/

12.2.2.11 Algorithm Input Values by Measure

Table 12-2. Measure Lookup Values - High Efficiency Evaporator Fan Motors

Measure	kWb_{ase}	DSF	ESF	OpHrs	CF	DIF	EIF	Incremental Cost ($/motor)
High-Efficiency Evaporator Fan Motors (EC)	0.34	0.53	0.53	6714	0.87	0.5	0.5	$171.58
High-Efficiency Evaporator Fan Motors (PSC)	0.34	0.41	0.41	6714	0.87	0.5	0.5	$141.86

12.2.3 Hi-Efficiency Refrigerator

12.2.3.1 Applicability

Replace on Burnout and New Construction

12.2.3.2 Applicable Programs

This measure is applicable to APS' Solutions for Business programs, which include:

- » Large Existing
- » New Construction
- » Small Business
- » Schools

12.2.3.3 Measure Description

This refrigeration end-use measure promotes the replacement or installation of standard supermarket reach-in refrigerated cases with ENERGY STAR-rated high-efficiency cases, which are designed with components such as ECM evaporators and condenser fan motors, hot gas anti-sweaters or high efficiency compressors.

12.2.3.4 Baseline Equipment Definition

The baseline case refers to a standard supermarket reach-in refrigerated case.

12.2.3.5 Efficient Equipment Definition

The efficient case refers to an ENERGY STAR supermarket reach-in refrigerated case with components such as ECM evaporators and condenser fan motors, hot gas anti-sweaters or high efficiency compressors.

12.2.3.6 Unit Basis

This measure's incentive, savings, and incremental measure cost are determined on a "per refrigerator" basis.

12.2.3.7 Effective Useful Life

This measure has an effective useful life of 15 years based on engineering judgment.

12.2.3.8 Incremental Measure Cost

The incremental cost for this measure varies depending on the number of refrigerator doors and includes the total material and labor costs. Incremental costs are based on interviews with industry experts and secondary sources. Specific incremental costs can be found in Table 12-3.

12.2.3.9 Annual Energy Savings Algorithm

The following algorithm is used to estimate annual energy saving impacts for this measure. Numeric values for the variables can be found in Table 12-3.

$$\Delta kWh = kWh_{base} \times ESF$$

Where:

ΔkWh	=	Energy savings for measure (in kWh)
kWh_{base}	=	Baseline Annual Energy Usage
ESF	=	Energy Savings Factor

12.2.3.10 Coincident Peak Demand Savings Algorithm

The following algorithm is used to estimate annual coincident peak demand saving impacts for this measure. Numeric values for the variables can be found in Table 12-3.

$$\Delta kW_{coincident} = \frac{kWh_{base}}{LF \times 8760} \times DSF \times CF$$

Where:

$\Delta kW_{coincident}$	=	Coincident peak demand savings for this measure (in kW)
kWh_{base}	=	Baseline Annual Energy Usage
LF	=	Load Factor
DSF	=	Demand Savings Factor
CF	=	Coincidence Factor

12.2.3.11 Algorithm Input Values by Measure

Table 12-3. Measure Lookup Values - High Efficiency Refrigerators

Measure	kWh_{base}	DSF	ESF	CF	LF	Incremental Cost ($/refrigerator)
High-Efficiency Refrigerator (1 Door)	1605.5	0.15	0.15	0.87	0.60	$103.04
High-Efficiency Refrigerator (2 Door)	2497.6	0.17	0.17	0.87	0.60	$153.47
High-Efficiency Refrigerator (3 Door)	2564.0	0.16	0.16	0.87	0.60	$200.67

12.2.4 Hi-Efficiency Freezer

12.2.4.1 Applicability

Replace on Burnout and New Construction

12.2.4.2 Applicable Programs

This measure is applicable to APS' Solutions for Business programs, which include:

- Large Existing
- New Construction
- Small Business
- Schools

12.2.4.3 Measure Description

This refrigeration end-use measure promotes the replacement or installation of standard supermarket reach-in freezer cases with ENERGY STAR-rated high-efficiency cases, which are designed with components such as ECM evaporators and condenser fan motors, hot gas anti-sweaters or high efficiency compressors.

12.2.4.4 Baseline Equipment Definition

The baseline case refers to a standard supermarket reach-in freezer case.

12.2.4.5 Efficient Equipment Definition

The efficient case refers to an ENERGY STAR supermarket reach-in freezer case with components such as ECM evaporators and condenser fan motors, hot gas anti-sweaters or high efficiency compressors.

12.2.4.6 Unit Basis

This measure's incentive, savings, and incremental measure cost are determined on a "per freezer" basis.

12.2.4.7 Effective Useful Life

This measure has an effective useful life of 15 years based on engineering judgment.

12.2.4.8 Incremental Measure Cost

The incremental cost for this measure varies depending on the number of freezer doors and includes the total material and labor costs. Incremental costs are based on interviews with industry experts and secondary sources. Specific incremental costs can be found in Table 12-4.

12.2.4.9 Annual Energy Savings Algorithm

The following algorithm is used to estimate annual energy saving impacts for this measure. Numeric values for the variables can be found in Table 12-4.

$$\Delta kWh = kWh_{base} \times ESF$$

Where:

ΔkWh	=	Energy savings for measure (in kWh)
kWh_{base}	=	Baseline Annual Energy Usage
ESF	=	Energy Savings Factor

12.2.4.10 Coincident Peak Demand Savings Algorithm

The following algorithm is used to estimate annual coincident peak demand saving impacts for this measure. Numeric values for the variables can be found in Table 12-4.

$$\Delta kW_{coincident} = \frac{kWh_{base}}{LF \times 8760} \times DSF \times CF$$

Where:

$\Delta kW_{coincident}$	=	Coincident peak demand savings for this measure (in kW)
kWh_{base}	=	Baseline Annual Energy Usage
LF	=	Load Factor
DSF	=	Demand Savings Factor
CF	=	Coincidence Factor

12.2.4.11 Algorithm Input Values by Measure

Table 12-4. Measure Lookup Values - High Efficiency Freezers

Measure	kWh_{base}	DSF	ESF	LF	CF	Incremental Cost ($/freezer)
High-Efficiency Freezer (1 Door)	4612.7	0.28	0.28	0.60	0.87	$145.04
High-Efficiency Freezer (2 Door)	7300.0	0.31	0.31	0.60	0.87	$225.26
High-Efficiency Freezer (3 Door)	9606.5	0.18	0.18	0.60	0.87	$309.00

12.2.5 Hi-Efficiency Ice Maker

12.2.5.1 Applicability

Replace on Burnout and New Construction

12.2.5.2 Applicable Programs

This measure is applicable to APS' Solutions for Business programs, which include:

- Large Existing
- New Construction
- Small Business
- Schools

12.2.5.3 Measure Description

This refrigeration end-use measure promotes the installation of high efficiency air-cooled or water-cooled icemakers with minimum capacity of 101 lbs of ice per 24-hour period.

12.2.5.4 Baseline Equipment Definition

The baseline case refers to a standard air-cooled or water-cooled icemaker.

12.2.5.5 Efficient Equipment Definition

The efficient case refers to an efficient air-cooled or water-cooled icemaker that adheres to minimum efficiency requirements per the Federal Energy Management Program guidelines and ENERGY STAR guidelines for water-cooled and air-cooled icemakers, respectively.

12.2.5.6 Unit Basis

This measure's incentive, savings, and incremental measure cost are determined on a "per ice maker" basis.

NAVIGANT

12.2.5.7 Effective Useful Life

This measure has an effective useful life of 12 years determined from the DEER 2008[82].

12.2.5.8 Incremental Measure Cost

The incremental cost for this measure varies depending on the minimum capacity of the ice maker and includes the total material and labor costs. Incremental costs are based on interviews with industry experts and secondary sources. Specific incremental costs can be found in Table 12-5.

12.2.5.9 Annual Energy Savings Algorithm

The following algorithm is used to estimate annual energy saving impacts for this measure. Numeric values for the variables can be found in Table 12-5.

$$\Delta kWh = kWh_{base} \times ESF$$

Where:

ΔkWh	=	Energy savings for measure (in kWh)
kWh_{base}	=	Baseline Annual Energy Usage (per 100 lbs)
ESF	=	Energy Savings Factor

12.2.5.10 Coincident Peak Demand Savings Algorithm

The following algorithm is used to estimate annual coincident peak demand saving impacts for this measure. Numeric values for the variables can be found in Table 12-5.

$$\Delta kW_{coincident} = \frac{kWh_{base}}{LF \times 8760} \times DSF \times CF$$

Where:

$\Delta kW_{coincident}$	=	Coincident peak demand savings for this measure (in kW)
kWh_{base}	=	Baseline Annual Energy Usage (per 100 lbs)
LF	=	Load Factor
DSF	=	Demand Savings Factor
CF	=	Coincidence Factor

[82] http://www.deeresources.com/

12.2.5.11 Algorithm Input Values by Measure

Table 12-5. Measure Lookup Values - High Efficiency Ice Makers

Measure	kWh_{base}	DSF	ESF	LF	CF	Incremental Cost ($/ice maker)
HiE Ice Makers - Air-Cooled - 0 to 100lbs	18.60	0.19	0.19	0.8	0.87	$79.11
HiE Ice Makers - Air-Cooled - 1001 to 1500lbs	4.63	0.14	0.14	0.8	0.87	$1030.65
HiE Ice Makers - Air-Cooled - 101 to 200lbs	13.81	0.19	0.19	0.8	0.87	$158.05
HiE Ice Makers - Air-Cooled - 201 to 300lbs	9.61	0.17	0.17	0.8	0.87	$316.96
HiE Ice Makers - Air-Cooled - 301 to 400lbs	8.32	0.16	0.16	0.8	0.87	$407.40
HiE Ice Makers - Air-Cooled - 401 to 500lbs	7.44	0.15	0.15	0.8	0.87	$491.50
HiE Ice Makers - Air-Cooled - 501 to 1000lbs	6.38	0.15	0.15	0.8	0.87	$630.08
HiE Ice Makers - Water-Cooled - 0 to 100lbs	13.98	0.37	0.37	0.8	0.87	$27.96
HiE Ice Makers - Water-Cooled - 1001 to 2000lbs	4.22	0.07	0.07	0.8	0.87	$987.62
HiE Ice Makers - Water-Cooled - 101 to 200lbs	10.91	0.37	0.37	0.8	0.87	$149.32
HiE Ice Makers - Water-Cooled - 201 to 300lbs	8.06	0.27	0.27	0.8	0.87	$342.88
HiE Ice Makers - Water-Cooled - 301 to 400lbs	7.15	0.21	0.21	0.8	0.87	$436.57
HiE Ice Makers - Water-Cooled - 401 to 500lbs	6.51	0.16	0.16	0.8	0.87	$516.76
HiE Ice Makers - Water-Cooled - 501 to 1000lbs	5.73	0.13	0.13	0.8	0.87	$638.06

12.2.6 Strip Curtains

12.2.6.1 Applicability

Retrofit

12.2.6.2 Applicable Programs

This measure is applicable to APS' Solutions for Business programs, which include:

» Large Existing
» New Construction
» Small Business
» Schools

12.2.6.3 Measure Description

This refrigeration end-use measure promotes the installation of new strip curtains or clear plastic swinging doors on doorways of walk-in boxes and refrigerated warehouses to limit loss of conditioned air.

12.2.6.4 Baseline Equipment Definition

The baseline case refers to walk-in boxes or refrigerated warehouses without strip curtains or clear plastic swinging doors.

12.2.6.5 Efficient Equipment Definition

The efficient case refers to walk-in boxes or refrigerated warehouses with strip curtains or clear plastic swinging doors.

12.2.6.6 Unit Basis

This measure's incentive, savings, and incremental measure cost are determined on a "per linear foot" basis for walk-in boxes and refrigerated warehouses.

12.2.6.7 Effective Useful Life

This measure has an effective useful life of 4 years determined from the DEER 2008[83].

12.2.6.8 Incremental Measure Cost

The incremental cost for this measure includes the total material and labor costs. Incremental costs are based on interviews with industry experts and secondary sources. Specific incremental costs can be found in Table 12-6.

12.2.6.9 Annual Energy Savings Algorithm

The following algorithm is used to estimate annual energy saving impacts for this measure. Numeric values for the variables can be found in Table 12-6.

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[83] http://www.deeresources.com/

$$\Delta kWh = \frac{Btuh_{base}}{EER \times 1000} \times ESF \times OpHrs$$

Where:

ΔkWh	=	Energy savings for measure (in kWh/LF)
$Btuh_{base}$	=	Case Load per Linear Foot (Btuh)
EER	=	Refrigerated System EER
ESF	=	Energy Savings Factor
OpHrs	=	Operating Hours

12.2.6.10 Coincident Peak Demand Savings Algorithm

The following algorithm is used to estimate annual coincident peak demand saving impacts for this measure. Numeric values for the variables can be found in Table 12-6.

$$\Delta kW_{coincident} = \frac{Btuh_{base}}{EER \times 1000} \times DSF \times CF$$

Where:

$\Delta kW_{coincident}$	=	Coincident peak demand savings for this measure (in kW/LF)
$Btuh_{base}$	=	Case Load per Linear Foot (Btuh)
EER	=	Refrigerated System EER
DSF	=	Demand Savings Factor
CF	=	Coincidence Factor

12.2.6.11 Algorithm Input Values by Measure

Table 12-6. Measure Lookup Values - Strip Curtains

Measure	$Btuh_{base}$	EER	DSF	ESF	CF	OpHrs	Incremental Cost ($/LF)
Strip Curtains	1300	8	0.18	0.46	0.87	6714	$43.35

12.2.7 Night Covers

12.2.7.1 Applicability

Retrofit

12.2.7.2 Applicable Programs

This measure is applicable to APS' Solutions for Business programs, which include:

- Large Existing
- New Construction
- Small Business

» Schools

12.2.7.3 Measure Description

This refrigeration end-use measure promotes the installation of a cover on open vertical or horizontal refrigerated case to decrease cooling loads.

12.2.7.4 Baseline Equipment Definition

The baseline case refers to open vertical or horizontal refrigerated cases.

12.2.7.5 Efficient Equipment Definition

The efficient case refers to open vertical or horizontal refrigerated cases with an installed cover to reduce cooling loads.

12.2.7.6 Unit Basis

This measure's incentive, savings, and incremental measure cost are determined on a "per linear foot" basis for refrigerated display cases.

12.2.7.7 Effective Useful Life

This measure has an effective useful life of 5 years determined from the DEER 2008[84].

12.2.7.8 Incremental Measure Cost

The incremental cost for this measure includes the total material and labor costs. Incremental costs are based on interviews with industry experts and secondary sources. Specific incremental costs can be found in Table 12-7.

12.2.7.9 Annual Energy Savings Algorithm

The following algorithm is used to estimate annual energy saving impacts for this measure. Numeric values for the variables can be found in Table 12-7.

$$\Delta kWh = \frac{Btuh_{base}}{EER \times 1000} \times ESF \times OpHrs$$

Where:

ΔkWh	=	Energy savings for measure (in kWh/LF)
$Btuh_{base}$	=	Case Load per Linear Foot (Btuh)

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[84] http://www.deeresources.com/

EER	=	Refrigerated System EER
ESF	=	Energy Savings Factor
OpHrs	=	Operating Hours

12.2.7.10 Coincident Peak Demand Savings Algorithm

The following algorithm is used to estimate annual coincident peak demand saving impacts for this measure. Numeric values for the variables can be found in Table 12-7.

$$\Delta kW_{coincident} = \frac{Btuh_{base}}{EER \times 1000} \times DSF \times CF$$

Where:

$\Delta kW_{coincident}$	=	Coincident peak demand savings for this measure (in kW/LF)
$Btuh_{base}$	=	Case Load per Linear Foot (Btuh)
EER	=	Refrigerated System EER
DSF	=	Demand Savings Factor
CF	=	Coincidence Factor

12.2.7.11 Algorithm Input Values by Measure

Table 12-7. Measure Lookup Values - Night Covers

Measure	$Btuh_{base}$	EER	DSF	ESF	CF	OpHrs	Incremental Cost ($/LF)
Night Covers	1300	8	0.00	0.37	0.87	6714	$40.52

12.2.8 Reach-in Cooler Controls

12.2.8.1 Applicability

Retrofit

12.2.8.2 Applicable Programs

This measure is applicable to APS' Solutions for Business programs, which include:

- Large Existing
- New Construction
- Small Business
- Schools

12.2.8.3 Measure Description

This refrigeration end-use measure promotes the installation of controls with passive infrared occupancy sensors to turn off fluorescent lights and other refrigerated system when the surrounding area is unoccupied for 15 minutes or longer.

12.2.8.4 Baseline Equipment Definition

The baseline case refers to refrigerated systems without occupancy sensor controls.

12.2.8.5 Efficient Equipment Definition

The efficient case refers to refrigerated systems with occupancy sensor controls to turn of fluorescent lights and other refrigerated systems when the surrounding area is unoccupied for 15 minutes or longer.

12.2.8.6 Unit Basis

This measure's incentive, savings, and incremental measure cost are determined on a "per reach-in cooler" basis for refrigerated systems.

12.2.8.7 Effective Useful Life

This measure has an effective useful life of 12 years determined from the DEER 2008[85].

12.2.8.8 Incremental Measure Cost

The incremental cost for this measure includes the total material and labor costs. Incremental costs are based on interviews with industry experts and secondary sources. Specific incremental costs can be found in Table 12-8.

12.2.8.9 Annual Energy Savings Algorithm

The following algorithm is used to estimate annual energy saving impacts for this measure. Numeric values for the variables can be found in Table 12-8.

$$\Delta kWh = kWh_{base} \times ESF$$

Where:

ΔkWh	=	Energy savings for measure (in kWh)
kWh_{base}	=	Baseline Annual Energy Usage
ESF	=	Energy Savings Factor

12.2.8.10 Coincident Peak Demand Savings Algorithm

The following algorithm is used to estimate annual coincident peak demand saving impacts for this measure. Numeric values for the variables can be found in Table 12-8.

[85] http://www.deeresources.com/

$$\Delta kW_{coincident} = \frac{kWh_{base}}{LF \times 8760} \times DSF \times CF$$

Where:

$\Delta kW_{coincident}$	=	Coincident peak demand savings for this measure (in kW)
kWh_{base}	=	Baseline Annual Energy Usage
LF	=	Load Factor
DSF	=	Demand Savings Factor
CF	=	Coincidence Factor

12.2.8.11 Algorithm Input Values by Measure

Table 12-8. Measure Lookup Values - Reach In Cooler Controls

Measure	kWh_{base}	DSF	ESF	CF	LF	Incremental Cost ($/cooler)
Reach-in Cooler Controls	4000	0.15	0.30	0.87	0.60	$168.50

12.2.9 Vending Machine Controls

12.2.9.1 Applicability

Retrofit

12.2.9.2 Applicable Programs

This measure is applicable to APS' Solutions for Business programs, which include:

- Large Existing
- New Construction
- Small Business
- Schools

12.2.9.3 Measure Description

This refrigeration end-use measure promotes the installation of controls with passive infrared occupancy sensors on beverage and snack machines to turn off fluorescent lights and other refrigerated system when the surrounding area is unoccupied for 15 minutes or longer.

12.2.9.4 Baseline Equipment Definition

The baseline case refers to beverage and snack machines' refrigerated systems without occupancy sensor controls.

12.2.9.5 Efficient Equipment Definition

The efficient case refers to beverage and snack machines' refrigerated systems with occupancy sensor controls to turn of fluorescent lights and other refrigerated systems when the surrounding area is unoccupied for 15 minutes or longer.

12.2.9.6 Unit Basis

This measure's incentive, savings, and incremental measure cost are determined on a "per machine" basis for refrigerated display cases.

12.2.9.7 Effective Useful Life

This measure has an effective useful life of 12 years determined from professional judgment.

12.2.9.8 Incremental Measure Cost

The incremental cost for this measure includes the total material and labor costs. Incremental costs are based on interviews with industry experts and secondary sources. Specific incremental costs can be found in Table 12-9.

12.2.9.9 Annual Energy Savings Algorithm

The following algorithm is used to estimate annual energy saving impacts for this measure. Numeric values for the variables can be found in Table 12-9.

$$\Delta kWh = kWh_{base} \times ESF$$

Where:

ΔkWh	=	Energy savings for measure (in kWh)
kWh_{base}	=	Baseline Annual Energy Usage
ESF	=	Energy Savings Factor

12.2.9.10 Coincident Peak Demand Savings Algorithm

The following algorithm is used to estimate annual coincident peak demand saving impacts for this measure. Numeric values for the variables can be found in Table 12-9.

$$\Delta kW_{coincident} = \frac{kWh_{base}}{LF \times 8760} \times DSF \times CF$$

Where:

$\Delta kW_{coincident}$	=	Coincident peak demand savings for this measure (in kW)
kWh_{base}	=	Baseline Annual Energy Usage
LF	=	Load Factor
DSF	=	Demand Savings Factor

CF	=	Coincidence Factor

12.2.9.11 Algorithm Input Values by Measure

Table 12-9. Measure Lookup Values - Vending Machine Controls

Measure	kWh_{base}	DSF	ESF	CF	LF	Incremental Cost ($/machine)
Beverage Machine Controls	3500	0.23	0.46	0.87	0.60	$192.50
Snack Machine Controls	700	0.23	0.46	0.87	0.60	$87.50

12.2.10 Floating Head Pressure Controls

12.2.10.1 Applicability

Retrofit

12.2.10.2 Applicable Programs

This measure is applicable to APS' Solutions for Business programs, which include:

» Large Existing
» New Construction
» Small Business
» Schools

12.2.10.3 Measure Description

This refrigeration end-use measure promotes the conversion of head pressure controls of an existing multiplex system from fixed control to floating control to take advantage of low outdoor-air temperatures.

12.2.10.4 Baseline Equipment Definition

The baseline case refers to a multiplex system with fixed controls.

12.2.10.5 Efficient Equipment Definition

The efficient case refers to a multiplex system with floating controls.

12.2.10.6 Unit Basis

This measure's incentive, savings, and incremental measure cost are determined on a "per ton" basis for refrigerated display cases.

12.2.10.7 Effective Useful Life

This measure has an effective useful life of 15 years determined from an engineering case study of refrigeration systems.

12.2.10.8 Incremental Measure Cost

The incremental cost for this measure includes the total material and labor costs. Incremental costs are based on interviews with industry experts and secondary sources. Specific incremental costs can be found in Table 12-10.

12.2.10.9 Annual Energy Savings Algorithm

The following algorithm is used to estimate annual energy saving impacts for this measure. Numeric values for the variables can be found in Table 12-10.

$$\Delta kWh = \frac{kWh_{base} \times ESF}{Capacity_{base}}$$

Where:

ΔkWh	=	Energy savings for measure (in kWh/ton)
kWh_{base}	=	Baseline Energy Consumption
ESF	=	Energy Savings Factor
$Capacity_{base}$	=	Baseline Capacity (tons)

12.2.10.10 Coincident Peak Demand Savings Algorithm

The following algorithm is used to estimate annual coincident peak demand saving impacts for this measure. Numeric values for the variables can be found in Table 12-10.

$$\Delta kW_{Coincident} = \frac{kWh_{base} \times DSF \times CF}{Capacity_{base} \times 8760}$$

Where:

$\Delta kW_{coincident}$	=	Coincident peak demand savings for this measure (in kW/ton)
kWh_{base}	=	Baseline Energy Consumption
DSF	=	Demand Savings Factor
CF	=	Coincidence Factor
$Capacity_{base}$	=	Baseline Capacity (tons)

12.2.10.11 Algorithm Input Values by Measure

Table 12-10. Measure Lookup Values - Floating Head Pressure Controls

Measure	kWh_{base}	DSF	ESF	CF	$Capacity_{base}$	Incremental Cost ($/ton)
Floating Head Pressure Controls	42182	0.16	0.16	1.00	3.74	$92.95

12.2.11 Automatic Door Closer

12.2.11.1 Applicability

Retrofit

12.2.11.2 Applicable Programs

This measure is applicable to APS' Solutions for Business programs, which include:

» Large Existing
» New Construction
» Small Business
» Schools

12.2.11.3 Measure Description

This refrigeration end-use measure promotes the installation of a new device to automatically close the main insulated door of an existing walk-in cooler or freezer.

12.2.11.4 Baseline Equipment Definition

The baseline case refers to an existing walk-in cooler or freezer without a device to automatically close the main insulated door.

12.2.11.5 Efficient Equipment Definition

The efficient case refers to an existing walk-in cooler or freezer with a device to automatically close the main insulated door.

12.2.11.6 Unit Basis

This measure's incentive, savings, and incremental measure cost are determined on a "per unit" basis for walk-in coolers or freezers.

12.2.11.7 Effective Useful Life

This measure has an effective useful life of 10 years determined from an engineering case study of refrigeration systems.

12.2.11.8 Incremental Measure Cost

The incremental cost for this measure includes the total material and labor costs. Incremental costs are based on interviews with industry experts and secondary sources. Specific incremental costs can be found in Table 12-11.

12.2.11.9 Annual Energy Savings Algorithm

The following algorithm is used to estimate annual energy saving impacts for this measure. Numeric values for the variables can be found in Table 12-11.

$$\Delta kWh = kWh_{base} \times ESF$$

Where:

ΔkWh	=	Energy savings for measure (in kWh)
kWh_{base}	=	Baseline Annual Energy Usage
ESF	=	Energy Savings Factor

12.2.11.10 Coincident Peak Demand Savings Algorithm

The following algorithm is used to estimate annual coincident peak demand saving impacts for this measure. Numeric values for the variables can be found in Table 12-11.

$$\Delta kW_{coincident} = kW_{base} \times DSF \times CF$$

Where:

$\Delta kW_{coincident}$	=	Coincident peak demand savings for this measure (in kW)
kW_{base}	=	Baseline Demand
DSF	=	Demand Savings Factor
CF	=	Coincidence Factor

12.2.11.11 Algorithm Input Values by Measure

Table 12-11. Measure Lookup Values - Automatic Door Closer

Measure	kWh_{base}	kW_{base}	DSF	ESF	CF	Incremental Cost ($/unit)
Auto Door Closer - Walk In Cooler	42182	4.82	0.08	0.08	1.00	$142.00
Auto Door Closer - Walk In Freezer	15524	1.77	0.23	0.23	1.00	$142.00

12.2.12 Efficient Condenser

12.2.12.1 Applicability

Replace on Burnout and New Construction

12.2.12.2 Applicable Programs

This measure is applicable to APS' Solutions for Business programs, which include:

» Large Existing
» New Construction
» Small Business
» Schools

12.2.12.3 Measure Description

This refrigeration end-use measure promotes the installation of a new higher-efficiency refrigeration condenser or replacement of an existing condenser with a higher-efficiency condenser.

12.2.12.4 Baseline Equipment Definition

The baseline case refers to an existing lower-efficiency refrigeration condenser or no condenser.

12.2.12.5 Efficient Equipment Definition

The efficient case refers to an existing walk-in cooler or freezer with a device to automatically close the main insulated door.

12.2.12.6 Unit Basis

This measure's incentive, savings, and incremental measure cost are determined on a "per ton" basis for refrigeration condensers.

12.2.12.7 Effective Useful Life

This measure has an effective useful life of 10 years determined from an engineering case study of refrigeration systems.

12.2.12.8 Incremental Measure Cost

The incremental cost for this measure includes the total material and labor costs. Incremental costs are based on interviews with industry experts and secondary sources. Specific incremental costs can be found in Table 12-12.

12.2.12.9 Annual Energy Savings Algorithm

The following algorithm is used to estimate annual energy saving impacts for this measure. Numeric values for the variables can be found in Table 12-12.

$$\Delta kWh = \frac{kWh_{base} \times ESF}{Capacity_{base}}$$

Where:

ΔkWh	=	Energy savings for measure (in kWh/ton)
kWh_{base}	=	Baseline Energy Consumption
ESF	=	Energy Savings Factor
$Capacity_{base}$	=	Baseline Capacity (tons)

12.2.12.10 Coincident Peak Demand Savings Algorithm

The following algorithm is used to estimate annual coincident peak demand saving impacts for this measure. Numeric values for the variables can be found in Table 12-12.

$$\Delta kW_{Coincident} = \frac{kWh_{base} \times CF}{Capacity_{base} \times 8760}$$

Where:

$\Delta kW_{coincident}$	=	Coincident peak demand savings for this measure (in kW/ton)
kWh_{base}	=	Baseline Energy Consumption
ESF	=	Energy Savings Factor
CF	=	Coincidence Factor
$Capacity_{base}$	=	Baseline Capacity (tons)

12.2.12.11 Algorithm Input Values by Measure

Table 12-12. Measure Lookup Values - Efficient Condenser

Measure	kWh_{base}	$Capacity_{base}$	ESF	CF	Incremental Cost ($/ton)
Efficient Condenser	120000	127	0.28	1.00	$39.47

12.2.13 Efficient Compressors

12.2.13.1 Applicability

Replace on Burnout and New Construction

12.2.13.2 Applicable Programs

This measure is applicable to APS' Solutions for Business programs, which include:

» Large Existing
» New Construction

- Small Business
- Schools

12.2.13.3 Measure Description

This refrigeration end-use measure promotes the replacement of existing hermetically sealed compressors with a more efficient compressor unit.

12.2.13.4 Baseline Equipment Definition

The baseline case refers to an existing hermetically sealed compressor.

12.2.13.5 Efficient Equipment Definition

The efficient case refers to a more efficient compressor.

12.2.13.6 Unit Basis

This measure's incentive, savings, and incremental measure cost are determined on a "per ton" basis for compressors.

12.2.13.7 Effective Useful Life

This measure has an effective useful life of 15 years determined from an engineering case study of refrigeration systems.

12.2.13.8 Incremental Measure Cost

The incremental cost for this measure includes the total material and labor costs. Incremental costs are based on interviews with industry experts and secondary sources. Specific incremental costs can be found in Table 12-13.

12.2.13.9 Annual Energy Savings Algorithm

The following algorithm is used to estimate annual energy saving impacts for this measure. Numeric values for the variables can be found in Table 12-13.

$$\Delta kWh = \frac{12}{3.412} \times \left(\frac{1}{COP_{base}} - \frac{1}{COP_{EE}}\right) \times DC \times 8760$$

Where:

ΔkWh	=	Energy savings for measure (in kWh/ton)
COP_{base}	=	Baseline Efficiency (COP)
COP_{EE}	=	EE Efficiency (COP)
DC	=	Duty Cycle

12.2.13.10 Coincident Peak Demand Savings Algorithm

The following algorithm is used to estimate annual coincident peak demand saving impacts for this measure. Numeric values for the variables can be found in Table 12-13.

$$\Delta kW_{coincident} = \frac{12}{3.412} \times \left(\frac{1}{COP_{base}} - \frac{1}{COP_{EE}}\right) \times DC$$

Where:

$\Delta kW_{coincident}$	=	Coincident peak demand savings for this measure (in kW/ton)
COP_{base}	=	Baseline Efficiency (COP)
COP_{EE}	=	EE Efficiency (COP)
DC	=	Duty Cycle

12.2.13.11 Algorithm Input Values by Measure

Table 12-13. Measure Lookup Values - High Efficiency Compressor

Measure	COP_{base}	COP_{EE}	DC	Incremental Cost ($/ton)
HiE Compressor - Bev Merchandiser	1.88	2.15	0.40	$105.60
HiE Compressor - Food Service Equip	1.63	2.15	0.66	$220.00
HiE Compressor - Freezer	1.37	1.67	0.65	$180.00
HiE Compressor - Refrigerator	2.35	2.55	0.50	$88.00
HiE Compressor - Walk In Cooler	3.42	4.14	0.66	$147.44
HiE Compressor - Walk In Freezer	1.00	1.20	0.70	$1611.36

13. SOLUTIONS FOR BUSINESS PROGRAM – ENVELOPE/ CONTROLS/MISCELLANEOUS

13.1 Algorithm Input Descriptions

13.1.1 Hours of Operation

The hours of operation is defined as the total number of hours that equipment is in operation. Annual hours of operation for different measure types are derived from a combination of data from the U.S. Department of Energy's (DOE) Benchmark Prototype Models[86] and the EUDAP conducted by APS. Variations within measures are due to different operating conditions for different buildings.

13.1.2 Load Factor (LF)

The LF is the ratio of maximum operating power or capacity of a measure to its nameplate power or capacity. Values are based on engineering models and secondary literature reviews specific to each measure.

13.1.3 Coincidence Factor (CF)

The CF is the fraction of the peak demand of a population that is in operation at the time of APS' system peak. Values are based on engineering models and secondary literature reviews specific to each measure.

13.1.4 Demand Savings Factor (DSF)

The DSF represents the percent savings over baseline energy demand. This value is based on a review of typical load shapes for commercial and industrial measure specific applications.

13.1.5 Energy Savings Factor (ESF)

The ESF represents the percent savings over baseline energy consumption. This value is based on a review of typical load shapes for commercial and industrial measure specific applications.

[86] http://www.energycodes.gov/development/commercial/90.1_models

13.1.6 Demand Interaction Factor (DIF)

The Demand Interaction Factor (DIF) accounts for interactive effects between PC demand and HVAC demand so that the estimated PC demand savings are the savings at the PC plug source in addition to any electrical savings at the cooling system.

13.1.7 Energy Interaction Factor (EIF)

The Energy Interaction Factor (EIF) accounts for interactive effects between PC energy consumption and HVAC energy consumption so that the estimated PC energy savings are the savings at the PC plug source in addition to any electrical savings at the cooling system.

13.1.8 Coefficient of Performance (COP)

The coefficient of performance (COP) of a heat pump is a ratio of cooling provided to electrical energy consumed.

13.1.9 Modified Energy Factor (MEF)87

The modified energy factor is an equation that takes into account the amount of dryer energy used to remove the remaining moisture content in washed items, in addition to the machine energy and water heating energy of the washer. MEF is the energy performance metric for ENERGY STAR qualified clothes washers. The higher the MEF, the more efficient the clothes washer is.

13.1.10 Adjustment Factor (Smart Strips)

Adjustment factors have been applied to the savings estimates for smart strips to account for units used/installed in such a way that typical savings will not be achieved.

13.1.11 Smart Strip Incremental Energy Use

The incremental energy use consumed by the smart strip.

13.2 Measure Characterizations

13.2.1 High Performance Window Glazing

13.2.1.1 Applicability

New Construction

[87] http://energystar.supportportal.com/link/portal/23002/23018/ArticleFolder/956/Clothes-Washers

13.2.1.2 Applicable Programs

This measure is applicable to APS' Solutions for Business programs, which include:

- Large Existing
- New Construction
- Small Business
- Schools

13.2.1.3 Measure Description

This measure promotes the installation of high performance windows and glass doors with any combination of glazing, coating, internal film and gas filling that meets the specified U-factor and Solar Heat Gain Coefficient (SHGC).

13.2.1.4 Baseline Equipment Definition

The baseline condition is a window with clear glazing, double pane, air filled, no coating and with U-factor = 0.5 and SHGC = 0.5.

13.2.1.5 Efficient Equipment Definition

Efficient equipment is a window with any combination of glazing, coating, internal film and gas filing that meets U-factor ≤ 0.32 and SHGC ≤ 0.40.

13.2.1.6 Unit Basis

This measure's incentive, savings and incremental measure cost are determined based on a "per sq ft of window area" basis.

13.2.1.7 Effective Useful Life

This measure has an effective useful life of 20 years.

13.2.1.8 Incremental Measure Cost

The incremental cost per sq ft for this measure varies depending on the unit type, unit size and includes the total material and labor costs. Incremental costs are based on participating contractor interviews and review of program invoices. For details of specific incremental cost calculations, refer to the MAS.

13.2.1.9 Annual Energy Savings Algorithm

Numeric values for the variables can be found in Table 13-1. Energy savings for high performance windows glazing are based on historical participation data and energy simulation modeling and are presented as deemed savings. The total annual savings of high performance windows glazing are determined based on a "per sq ft" basis.

13.2.1.10 Coincident Peak Demand Savings Algorithm

Numeric values for the variables can be found in Table 13-1. Coincident demand savings for high performance windows glazing are based on historical participation data and energy simulation modelling and are presented as deemed savings. The total annual coincident demand savings of high performance windows glazing are determined based on a "per sq ft" basis.

13.2.1.11 Algorithm Input Values by Measure

Table 13-1: Measure Lookup Values - High Performance Glazing

Measure Type	Annual Energy Savings (kWh/sq ft)	Annual Demand Savings (kW/sq ft)	Incremental Cost ($/sq ft)
High Performance Glazing	3.6	0.0016	2.34

13.2.2 Smart Strips

13.2.2.1 Applicability

Retrofit

13.2.2.2 Applicable Programs

This measure is applicable to APS' Solutions for Business programs, which include:

» Large Existing
» New Construction
» Small Business
» Schools

13.2.2.3 Measure Description

This appliance measure promotes the installation of plug-load smart strips to control electricity using equipment in offices or cubicles, including lighting, monitors, shared copiers, and/or printers.

13.2.2.4 Baseline Equipment Definition

Baseline equipment is a standard power strips that does not control for occupancy or load. Baseline energy consumption estimates are based on analysis of various configurations of desktop office equipment and usage patterns. Table 13-2 displays the assumed baseline equipment load for various numbers of outlets.

Table 13-2: Smart Strip Baseline Input Values

Measure Type	Size	Number of Smart Strips	Base Energy (kWh/outlet)
Occupancy Sensor	8-outlet	1	634.3
Load Sensor	6-outlet	1	634.1
Load Sensor	7-outlet	1	634.3
Load Sensor	8-outlet	1	671.1
Load Sensor	10-outlet	1	769.9
Timer Plug	8-outlet	1	634.3

13.2.2.5 Efficient Equipment Definition

The efficient equipment definition can be one of three smart strip types:

- ***Occupancy Sensor:*** Passive infrared and/or ultrasonic detectors for plug-load office equipment.
- ***Load Sensor:*** Load-sensing smart plug strips detecting a drop in current when a control device enters low-power mode.
- ***Timer Plug:*** Timer plug that can turn equipment on and off based on programmable timer. This device should be used on equipment that requires a long warm-up.

13.2.2.6 Unit Basis

This measure's incentive, savings and incremental measure cost are determined based on a "per unit" basis.

13.2.2.7 Effective Useful Life

This measure has an effective useful life of 12 years determined based on information in "Final Report Electronics and Energy Efficiency: A Plug Load Characterization Study."

13.2.2.8 Incremental Measure Cost

The incremental cost per sensor for this measure varies depending on the outlet type that the sensor is installed on. For details of specific incremental cost calculations, refer to the MAS.

13.2.2.9 Annual Energy Savings Algorithm

The following algorithm is used to estimate annual energy saving impacts for this measure. Numeric values for the variables can be found in Table 13-3. Please refer to Table 13-2 for baseline energy consumption.

$$\Delta kWh = (kWh_{base} - kWh_{ee}) \times AF - IES$$

Where:

ΔkWh	=	Energy savings for measure (in kWh)
kWh_{base}	=	Baseline equipment energy consumption
kWh_{ee}	=	Efficient equipment energy consumption, after smart strip installation
AF	=	Adjustment Factor
IEU	=	Smart Strip Incremental Energy Use

13.2.2.10 Coincident Peak Demand Savings Algorithm

Assuming that most smart strips are powered during the coincident peak, there are no expected coincident peak demand savings impacts for this measure.

13.2.2.11 Algorithm Input Values by Measure

Please refer to Table 13-2 for baseline energy consumption.

Table 13-3: Measure Lookup Values - Smart Strip

Measure Type	Size	Number of Smart Strips	EE Energy (kWh/outlet)	AF	CF	Incremental Energy Usage (kWh/outlet)	Incremental Cost ($/unit)
Occupancy Sensor	8-outlet	1	371.4	0.7	0.0	14.0	79.00
Load Sensor	6-outlet	1	497.1	0.8	0.0	14.0	24.00
Load Sensor	7-outlet	1	500.4	0.8	0.0	14.0	23.50
Load Sensor	8-outlet	1	514.4	0.8	0.0	14.0	21.00
Load Sensor	10-outlet	1	564.1	0.8	0.0	14.0	21.00
Timer Plug	8-outlet	1	351.1	0.8	0.0	14.0	8.00

13.2.3 Shade Screens

13.2.3.1 Applicability

Retrofit

13.2.3.2 Applicable Programs

This measure is applicable to APS' Solutions for Business programs, which include:

- Large Existing
- New Construction
- Small Business
- Schools

13.2.3.3 Measure Description

This measure promotes the addition of exterior physical shading screens to windows.

13.2.3.4 Baseline Equipment Definition

The baseline definition is a window with no exterior shading screens.

13.2.3.5 Efficient Equipment Definition

The efficient definition is a window with exterior shading screens with shading coefficient equal to .30 or less at a thirty-degree profile angle.

13.2.3.6 Unit Basis

This measure's incentive, savings and incremental measure cost are determined based on a "per sq ft" basis.

13.2.3.7 Effective Useful Life

This measure has an effective useful life of 10 years determined from DEER 2008[88].

13.2.3.8 Incremental Measure Cost

The incremental cost per sq ft for this measure varies depending on the unit type, unit size and includes the total material and labor costs. Incremental costs are based on participating contractor interviews and review of program invoices. For details of specific incremental cost calculations, refer to the MAS.

13.2.3.9 Annual Energy Savings Algorithm

Numeric values for the variables can be found in Table 13-4. Energy savings for shade screens are based on energy model simulations and thus presented as deemed savings. The total annual savings of shade screens are determined based on a "per sq ft" basis.

13.2.3.10 Coincident Peak Demand Savings Algorithm

Numeric values for the variables can be found in Table 13-4. Coincident demand savings for shade screens are based on energy model simulations and thus presented as deemed savings. The total annual coincident demand savings of shade screens are determined based on a "per sq ft" basis.

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[88] http://www.deeresources.com/

13.2.3.11 Algorithm Input Values by Measure

Table 13-4: Measure Lookup Values - Shade Screen

Measure Type	Annual Energy Savings (kWh/sqft)	Annual Demand Savings (kW/sqft)	Incremental Cost ($/sqft)
Shade Screens	21.14	0.004	4.13

13.2.4 PC Management Software

13.2.4.1 Applicability

Retrofit

13.2.4.2 Applicable Programs

This measure is applicable to APS' Solutions for Business programs, which include:

- » Large Existing
- » New Construction
- » Small Business
- » Schools

13.2.4.3 Measure Description

This controls measure promotes the installation of computer power management software to allow computers to be put into low-power settings during appropriate hours.

13.2.4.4 Baseline Equipment Definition

Computers or laptops without computer power management software.

13.2.4.5 Efficient Equipment Definition

Computers or laptops with computer power management software that automatically controls the power settings of networked personal computers at the server level. The software is also capable of managing power consumption for each individual PC and reporting energy savings results.

13.2.4.6 Unit Basis

This measure's incentive, savings, and incremental measure cost are determined based on a "per personal computer" basis.

13.2.4.7 Effective Useful Life

This measure has an effective useful life of 4 years assumed to be equal to a typical computer life.

13.2.4.8 Incremental Measure Cost

The incremental cost per PC for this measure varies depending on the unit type and includes the total software and labor costs. Incremental costs are based on manufacturer data. For details of specific incremental cost calculations, refer to the MAS.

13.2.4.9 Annual Energy Savings Algorithm

The following algorithm is used to estimate annual energy saving impacts for this measure. Numeric values for the variables can be found in Table 13-5.

$$\Delta kWh = kWh_{sav} \times (1 + EIF)$$

Where:

ΔkWh	=	Energy savings for measure (in kWh)
kWh_{sav}	=	Constant, Energy saved per PC (kWh)
EIF	=	HVAC Energy Interaction Factor

13.2.4.10 Coincident Peak Demand Savings Algorithm

The following algorithm is used to estimate annual demand saving impacts for this measure. Numeric values for the variables can be found in Table 13-5. Coincident demand savings are assumed to be zero as savings are assumed to be off peak for this measure.

$$\Delta kW_{coincident} = kW_{sav} \times (1 + DIF) \times CF$$

Where:

$\Delta kW_{coincident}$	=	Coincident peak demand savings for this measure (in kW)
kW_{sav}	=	Constant, Power saved per PC (kW)
DIF	=	HVAC Demand Interaction Factor
CF	=	Coincidence Factor

13.2.4.11 Algorithm Input Values by Measure

Table 13-5: Measure Lookup Values - Computer Power Management

Measure Type	Energy Saved per PC (kWh)	Power Saved per PC (kW)	HVAC Interaction Factor (Energy)	HVAC Interaction Factor (Demand)	CF	Incremental Cost ($/unit)
Computer PM	243.3	0.132	17%	20%	0.0	12.14
Laptop PM	100.37	0.018	17%	20%	0.0	12.14

Source: Energy Star

13.2.5 Heat Pump Domestic Hot Water Heater

13.2.5.1 Applicability

Replace on Burnout and New Construction

13.2.5.2 Applicable Programs

This measure is applicable to APS' Solutions for Business programs, which include:

- Large Existing
- New Construction
- Small Business
- Schools

13.2.5.3 Measure Description

This appliance measure promotes the replacement of existing electric domestic hot-water heater with a heat pump domestic hot-water heater.

13.2.5.4 Baseline Equipment Definition

Table 13-6 presents the efficiencies of baseline water heaters and the assumed annual energy consumption of baseline units.

Table 13-6: Heat Pump Water Heater Baseline Energy Efficiencies

Measure Type	Baseline EE	Baseline Energy (kWh/tank)
Full Service Restaurant HPWH	86%	11,589
Quick Service Restaurant HPWH	86%	12,030
Full Service Restaurant HPWH	86%	11,589
Quick Service Restaurant HPWH	86%	12,030

13.2.5.5 Efficient Equipment Definition

The efficient case is a heat pump hot water heater with a COP of 2.35 or greater.

13.2.5.6 Unit Basis

This measure's incentive, incremental measure cost, and savings are determined based on a "per unit/tank" basis.

13.2.5.7 Effective Useful Life

This measure has an effective useful life of 13 years.

13.2.5.8 Incremental Measure Cost

The incremental cost per HPWH for this measure varies depending on the unit type. Incremental costs are based on ENERGY STAR and ACEEE data. For details of specific incremental cost calculations, refer to the MAS.

13.2.5.9 Annual Energy Savings Algorithm

The following algorithm is used to estimate annual energy saving impacts for this measure. Numeric values for the variables can be found in Table 13-7.

$$\Delta kWh = (kWh_{base} - kWh_{ee})$$

Where:

ΔkWh	=	Energy savings for measure (in kWh)
kWh_{base}	=	Baseline equipment energy consumption per tank
kWh_{ee}	=	Efficient equipment energy consumption per tank

13.2.5.10 Coincident Peak Demand Savings Algorithm

The following algorithm is used to estimate annual demand saving impacts for this measure. Numeric values for the variables can be found in Table 13-7.

$$\Delta kW_{coincident} = \frac{(kWh_{base} - kWh_{ee})}{365} \times CF$$

Where:

$\Delta kW_{coincident}$	=	Coincident peak demand savings for this measure (in kW)
kWh_{base}	=	Baseline equipment energy consumption per tank
kWh_{ee}	=	Efficient equipment energy consumption per tank
365	=	Number of days in a year
CF	=	Coincidence Factor

13.2.5.11 Algorithm Input Values by Measure

Table 13-7: Measure Lookup Values - Heat Pump Water Heater

Measure Type	COP Range	Water Tank Capacity (gal)	EE Efficiency	EE Energy (kWh/tank)	CF	Incremental Cost ($/unit)
Full Service Restaurant HPWH	≥ 2.35 and < 2.5	80	235%	4241	0.04	1910
Quick Service Restaurant HPWH	≥ 2.35 and < 2.5	80	235%	4402	0.04	1910
Full Service Restaurant HPWH	≥ 2.5	80	251%	3971	0.04	2777
Quick Service Restaurant HPWH	≥ 2.5	80	251%	4122	0.04	2777

13.2.6 Coin Operated Laundry

13.2.6.1 Applicability

Replace on Burnout and New Construction

13.2.6.2 Applicable Programs

This measure is applicable to APS' Solutions for Business programs, which include:

- Large Existing
- New Construction
- Small Business
- Schools

13.2.6.3 Measure Description

This appliance measure promotes the replacement of existing clothes washers with energy efficient clothes washers.

13.2.6.4 Baseline Equipment Definition

Table 13-8 displays the baseline condition assumptions for coin-operated clothes washers.

Table 13-8. Coin Operated Clothes Washers Baseline Assumptions

Measure Type	Base Energy (kWh/year)	MEF_{base} (ft^3/kWh)
CEE Tier 1/Energy Star	1319	1.26
CEE Tier 2	1319	1.26
CEE Tier 3	1319	1.26
CEE Tier 4	1319	1.26

Source: Consortium for Energy Efficiency

13.2.6.5 Efficient Equipment Definition

Efficient equipment is clothes washers with efficiency ratings specified by the corresponding Consortium for Energy Efficiency tiers.

13.2.6.6 Unit Basis

This measure's incentive, incremental measure cost, and savings are determined based on a "per unit."

13.2.6.7 Effective Useful Life

This measure has an effective useful life of 11 years determined based on DOE Energy Star calculator.

13.2.6.8 Incremental Measure Cost

The incremental cost per clothes washer for this measure varies depending on the unit type, unit capacity. Incremental costs are based on manufacturer data. For details of specific incremental cost calculations, refer to the MAS.

13.2.6.9 Annual Energy Savings Algorithm

The following algorithm is used to estimate annual energy savings impacts for this measure. Numeric values for the variables can be found in Table 13-9.

$$\Delta kWh = kWh_{base} \times \left(1 - \frac{MEF_{base}}{MEF_{ee}}\right)$$

Where:

ΔkWh	=	Energy savings for measure (in kWh)
kWh_{base}	=	Baseline equipment energy consumption per unit

MEF_{base}	=	Modified energy factor for baseline equipment (in ft³/kWh)
MEF_{ee}	=	Modified energy factor for efficient equipment (in ft³/kWh)

13.2.6.10 Coincident Peak Demand Savings Algorithm

The following algorithm is used to estimate annual demand saving impacts for this measure. Numeric values for the variables can be found in Table 13-9.

$$\Delta kW_{coincident} = \frac{kWh_{base} \times \left(1 - \frac{MEF_{base}}{MEF_{ee}}\right)}{365} \times CF$$

Where:

$\Delta kW_{coincident}$	=	Coincident peak demand savings for this measure (in kW)
kWh_{base}	=	Baseline equipment energy consumption
MEF_{base}	=	Modified energy factor for baseline equipment (in ft³/kWh)
MEF_{ee}	=	Modified energy factor for efficient equipment (in ft³/kWh)
CF	=	Coincidence Factor

13.2.6.11 Algorithm Input Values by Measure

Table 13-9: Measure Lookup Values - Coin-Operated Washing Machine

Measure Type	Machine Capacity (ft³)	Loads Per Year	MEF_{ee} (ft³/kWh)	CF	Incremental Cost ($/unit)
CEE Tier 1/Energy Star	4.0	950	2	0.05	211
CEE Tier 2	4.0	950	2.2	0.05	326
CEE Tier 3	4.0	950	2.4	0.05	307
CEE Tier 4	4.0	950	2.6	0.05	537

Source: CEE

13.2.7 Carbon Dioxide Sensor

13.2.7.1 Applicability

Retrofit

13.2.7.2 Applicable Programs

This measure is applicable to APS' Solutions for Business programs, which include:

- Large Existing
- New Construction
- Small Business
- Schools

13.2.7.3 Measure Description

This control measure promotes the installation of CO_2 sensors to utilize demand-controlled ventilation to reduce the conditioning of outside air.

13.2.7.4 Baseline Equipment Definition

Baseline equipment is a ventilation fan with no CO_2 sensors installed.

13.2.7.5 Efficient Equipment Definition

Efficient equipment is a ventilation fan with CO_2 sensors.

13.2.7.6 Unit Basis

This measure's incentive, savings and incremental measure cost are determined based on a "per sensor" basis.

13.2.7.7 Effective Useful Life

This measure has an effective useful life of 15 years per Energy Innovation Group technical specs for transmitter rated life.

13.2.7.8 Incremental Measure Cost

The incremental cost per sensor for this measure varies depending on the unit type. Incremental costs are based on recommendations from the Federal Energy Management Program[89]. For details of specific incremental cost calculations, refer to the MAS.

13.2.7.9 Annual Energy Savings Algorithm

Energy savings are based on an engineering spreadsheet model calibrated to APS weather data. Numeric values for the deemed savings values and assumptions driving the model can be found in Table 13-10. For further model detail please refer to the MAS.

13.2.7.10 Coincident Peak Demand Savings Algorithm

Coincident peak demand savings are based on an engineering spreadsheet model calibrated to APS weather data. Numeric values for the deemed savings values and assumptions driving the model can be found in Table 13-10. For further model detail please refer to the MAS.

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[89] https://www1.eere.energy.gov/femp/

13.2.7.11 Algorithm Input Values by Measure

Table 13-10: Lookup Values - CO_2 Sensor Measure

Measure Type	Sector	Area per sensor (sq ft)	Occupants per Sensor	ESF	CF	Coincident Demand Savings (kW)	Energy Savings (kWh)	Incremental Cost ($/unit)
CO_2 Sensor/DCV	College/Univ	5000	72	63%	43%	1.5	1176	950
CO_2 Sensor/DCV	Data Center	8000	26	63%	43%	1.6	1176	950
CO_2 Sensor/DCV	Grocery	8000	19	63%	50%	2.1	1433	950
CO_2 Sensor/DCV	Hotel/Motel	8000	25	20%	40%	0.8	911	950
CO_2 Sensor/DCV	K-12 School	8000	29	63%	15%	0.5	1186	950
CO_2 Sensor/DCV	Medical	8000	75	63%	87%	1.7	537	950
CO_2 Sensor/DCV	Misc	8000	40	20%	43%	1.5	1176	950
CO_2 Sensor/DCV	Office	8000	10	20%	30%	0.6	531	950
CO_2 Sensor/DCV	Other Industrial	8000	42	63%	43%	1.5	1176	950
CO_2 Sensor/DCV	Process Industrial	8000	42	20%	43%	1.5	1176	950
CO_2 Sensor/DCV	Restaurant	8000	42	20%	45%	3.2	3051	950
CO_2 Sensor/DCV	Retail	8000	42	63%	50%	3.2	1971	950
CO_2 Sensor/DCV	Warehouse	8000	10	35%	0%	0.0	138	950

13.2.8 Carbon Monoxide Sensor

13.2.8.1 Applicability

Retrofit

13.2.8.2 Applicable Programs

This measure is applicable to APS' Solutions for Business programs, which include:

» Large Existing
» New Construction
» Small Business
» Schools

13.2.8.3 Measure Description

This control measure promotes the installation of CO sensors to control parking garage exhaust fans.

13.2.8.4 Baseline Equipment Definition

Baseline equipment is a parking garage ventilation fan with no CO sensors.

13.2.8.5 Efficient Equipment Definition

Energy efficient equipment is a parking garage ventilation fan with CO sensors.

13.2.8.6 Unit Basis

This measure's incentive, savings and incremental measure cost are determined based on a "per sensor" basis.

13.2.8.7 Effective Useful Life

This measure has an effective useful life of 8 years determined from DEER 2008[90].

13.2.8.8 Incremental Measure Cost

The incremental cost per sensor for this measure varies depending on the unit type. For details of specific incremental cost calculations, refer to the MAS.

13.2.8.9 Annual Energy Savings Algorithm

Annual energy savings are estimated using an engineering spreadsheet model. The following algorithm is used to estimate annual energy saving impacts for this measure. Numeric values for the variables can be found in Table 13-11. For model specifics please refer to the MAS.

$$\Delta kWh = VPD \times OpHrs \times Area \times ESF$$

Where:

ΔkWh	=	Energy savings for measure (in kWh)
VPD	=	Ventilation Power Density (W/sqft)
OpHrs	=	Annual Operation Hours
Area	=	Area per sensor (in sqft)
ESF	=	Energy Savings Factor

[90] http://www.deeresources.com/

13.2.8.10 Coincident Peak Demand Savings Algorithm

Coincident demand savings are estimated using an engineering spreadsheet model. Numeric values for the deemed savings values and the variables can be found in Table 13-11. For model specifics please refer to the MAS.

13.2.8.11 Algorithm Input Values by Measure

Table 13-11: Measure Lookup Values - CO Sensors

Measure Type	Sector	Ventilation Power Density (W/sq.ft.)	Annual Operation Hours	Area per sensor (sqft)	ESF	Coincident Demand Savings (kW)	Incremental Cost ($/unit)
CO Sensor/VAV	Industrial	1.2	8760	8000	63%	0.0	2000
CO Sensor/VAV	College/Univ	1.2	8760	8000	63%	0.0	2000
CO Sensor/VAV	Data Center	1.2	8760	8000	63%	0.0	2000
CO Sensor/VAV	Grocery	1.2	8760	8000	20%	6.3	2000
CO Sensor/VAV	Hotel/Motel	1.2	8760	8000	63%	0.0	2000
CO Sensor/VAV	K-12 School	1.2	8760	8000	63%	0.0	2000
CO Sensor/VAV	Medical	1.2	8760	8000	20%	6.3	2000
CO Sensor/VAV	Misc	1.2	8760	8000	20%	6.3	2000
CO Sensor/VAV	Office	1.2	8760	8000	63%	0.0	2000
CO Sensor/VAV	Restaurant	1.2	8760	8000	20%	6.3	2000
CO Sensor/VAV	Retail	1.2	8760	8000	20%	6.3	2000
CO Sensor/VAV	Warehouse	1.2	8760	8000	63%	0.0	2000
CO Sensor/on-off	Industrial	1.2	8760	8000	35%	0.0	2000
CO Sensor/on-off	College/Univ	1.2	8760	8000	35%	0.0	2000

CO Sensor/on-off	Data Center	1.2	8760	8000	35%	0.0	2000
CO Sensor/on-off	Grocery	1.2	8760	8000	14%	2.9	2000
CO Sensor/on-off	Hotel/Motel	1.2	8760	8000	35%	0.0	2000
CO Sensor/on-off	K-12 School	1.2	8760	8000	35%	0.0	2000
CO Sensor/on-off	Medical	1.2	8760	8000	14%	2.9	2000
CO Sensor/on-off	Misc	1.2	8760	8000	14%	2.9	2000
CO Sensor/on-off	Office	1.2	8760	8000	35%	0.0	2000
CO Sensor/on-off	Restaurant	1.2	8760	8000	14%	2.9	2000
CO Sensor/on-off	Retail	1.2	8760	8000	14%	2.9	2000
CO Sensor/on-off	Warehouse	1.2	8760	8000	35%	0.0	2000

13.2.9 Hotel Room Occupancy Control

13.2.9.1 Applicability

Retrofit

13.2.9.2 Applicable Programs

This measure is applicable to APS' Solutions for Business programs, which include:

- Large Existing
- New Construction

13.2.9.3 Measure Description

This control measure promotes the installation of hotel room occupancy control devices to automatically setback room temperature and shut off lighting when the room is unoccupied.

13.2.9.4 Baseline Equipment Definition

Baseline equipment is a hotel room HVAC and lighting system with no occupancy controls.

13.2.9.5 Efficient Equipment Definition

Efficient equipment includes passive and/or dual technology room occupancy sensors and room keycard activation installed to control a hotel room HVAC and lighting system.

13.2.9.6 Unit Basis

This measure's savings and incremental measure cost are determined based on a "per sensor" basis.

13.2.9.7 Effective Useful Life

This measure has an effective useful life of 8 years.

13.2.9.8 Incremental Measure Cost

The incremental cost per sensor for this measure varies depending on the unit type and includes labor cost. For details of specific incremental cost calculations, refer to the MAS.

13.2.9.9 Annual Energy Savings Algorithm

The following algorithm is used to estimate energy saving impacts for this measure. Numeric values for the variables can be found in Table 13-12.

$$\Delta kWh = \frac{CL}{1000} \times OpHrs \times ESF$$

Where:

ΔkWh	=	Energy savings for measure (in kWh)
CL	=	Connected HVAC Load (W/sensor)
OpHrs	=	Annual operating hours of HVAC load
ESF	=	Energy Savings Factor

13.2.9.10 Coincident Peak Demand Savings Algorithm

The following algorithm is used to estimate demand saving impacts for this measure. Numeric values for the variables can be found in Table 13-12.

$$\Delta kW_{coincident} = \frac{CL}{1000} \times DSF \times CF$$

Where:

$\Delta kW_{coincident}$	=	Coincident peak demand savings for this measure (in kW)
CL	=	Connected Load (W/sensor)
DSF	=	Demand Savings Factor
CF	=	Coincidence Factor

13.2.9.11 Algorithm Input Values by Measure

Table 13-12: Measure Lookup Values - Hotel Room Occupancy Sensor

Measure Type	Radius per sensor	Annual Operation Hours	Area per sensor (sqft)	Connected Load (W)	ESF	DSF	CF	Incremental Cost ($/unit)
Dual Technology	180	2187	1000	1025	40%	67%	0.25	178
Passive Infrared	360	2187	1500	1025	39%	67%	0.25	139
Key Card Activation	360	2187	325	1025	25%	67%	0.16	220

13.2.10 Energy Management Systems

13.2.10.1 Applicability

Retrofit

13.2.10.2 Applicable Programs

This measure is applicable to APS' Solutions for Business programs, which include:

» Large Existing
» New Construction
» Small Business
» Schools

13.2.10.3 Measure Description

This measure promotes the installation of energy management system (EMS) to optimize system operation.

13.2.10.4 Baseline Equipment Definition

Baseline equipment is an HVAC system with one of the following controls:

1) non-programmable or pneumatic thermostats;
2) programmable thermostats or digital EMS.

13.2.10.5 Efficient Equipment Definition

Efficient equipment requirements are divided into two tiers. Efficient equipment is EMS systems that meet Tier 1 requirements at a minimum, and Tier 2 requirements to be eligible for higher rebates. Energy savings estimates are determined based on Tier 1 requirements.

Tier 1 EMS Requirements:

- Central Time Control
- Graphic operator interface
- Trending capability
- Web-based interface with PC-based controls
- Minimum setback temperature of at least 8°F in both heating and cooling
- Minimum setback period exceeding 2,200 hours per year
- At least three enhanced control strategies from Table 13-13.

Tier 2 EMS Requirements:

- For direct-expansion (DX) systems: at least six enhanced control strategies
- For chilled water (CW) systems: at least ten enhanced control strategies
- For facilities with both DX and CW systems: at least ten enhanced control strategies

Table 13-13: EMS Enhanced Control Strategies

Enhanced Control Strategies	
1	Chilled Water Temperature Reset
2	Chiller Compressor Sequencing
3	Condenser Water Temperature Reset
4	Cooling Lockout on Outside Air Temperature (OSAT)
5	Cooling Tower Fan Speed Control
6	Cooling Tower Fan Staging
7	Deadband Control for Heating and Cooling
8	Demand Control Ventilation
9	Distribution Pump Speed Control
10	Distribution Pump Sequencing
11	Equipment Cycling
12	Heating Lockout on OSAT
13	Improved Outside Air Volume Control[1]
14	Morning Warm-up/ Cool Down Cycle
15	Night Ventilation Purge
16	Outside Air Damper Control
17	Optimal Start/Stop
18	Secondary Chilled Water Loop Pressure
19	Static Pressure Reset
20	Summer/Winter Volume Change
21	Supply Air Temperature Reset
22	Unoccupied Temperature Setback
23	Zone-by-Zone Scheduling

[1]Direct outdoor air measurement, volumetric fan tracking, fixed damper position, or plenum pressure differential.

13.2.10.6 Unit Basis

This measure's incentive, savings and incremental measure cost are determined based on a "per sq ft" basis.

13.2.10.7 Effective Useful Life

This measure has an effective useful life of 13 years determined based on DEER 2008[91] values.

13.2.10.8 Incremental Measure Cost

The incremental cost per sq ft for this measure varies depending on the unit type, unit size, and number of enhanced control strategies installed and includes the total material and labor costs. Incremental costs are based on review of program invoices. For details of specific incremental cost calculations, refer to the MAS.

13.2.10.9 Annual Energy Savings Algorithm

Numeric values for the variables can be found in Table 13-14. Energy savings for EMS are based on historical program data and thus presented as deemed savings. The total annual savings of EMS are determined based on a "per sq ft" basis.

13.2.10.10 Coincident Peak Demand Savings Algorithm

Numeric values for the variables can be found in Table 13-14. Coincident demand savings for EMS are based on EMS load shape analysis thus presented as deemed savings. The total annual coincident demand savings of EMS are determined based on a "per sq ft" basis.

13.2.10.11 Algorithm Input Values by Measure

Table 13-14: Measure Lookup Values - EMS

Measure Type	Annual Energy Savings (kWh/sq ft)	Annual Demand Savings (kW/sq ft)	Incremental Cost ($/sq ft)
EMS replacing T-stat or pneumatic controls	4.06	0.003	1.57
EMS replacing DDC or upgrading digital EMS	3.25	0.003	1.26

13.2.11 Demand Response Programmable Thermostats

Savings and costs for Demand Response Programmable Thermostats are consistent with those for programmable thermostats rebated through the S4B program. Please refer to Section 10.2.8for more information.

[91] http://www.deeresources.com/

13.2.12 Custom Measures

13.2.12.1 Applicability

Retrofit, Replace on Burnout, and New Construction

13.2.12.2 Applicable Programs

This measure is applicable to APS' Solutions for Business programs, which include:

» Large Existing
» New Construction
» Small Business
» Schools

13.2.12.3 Measure Description

APS offers custom rebates for energy-saving projects for which there is no prescriptive incentive. The rebates apply to retrofit and new construction projects and are funded at $0.09/annual kWh savings, up to 75% of incremental costs. Project savings, costs, measure lifetimes, and cost-effectiveness are calculated on a case-by-case basis by the program implementer, and leverage some of the algorithms and models discussed in other sections of this TRM.

13.2.12.4 Baseline Equipment Definition

The baseline definition is specific to the custom project and varies on a case-by-case basis.

13.2.12.5 Efficient Equipment Definition

The efficient definition is specific to the custom project and varies on a case-by-case basis.

13.2.12.6 Unit Basis

Savings and costs are based on a "per project" basis.

13.2.12.7 Effective Useful Life

The effective useful life is specific to the custom project and varies on a case-by-case basis.

13.2.12.8 Incremental Measure Cost

The incremental cost is specific to the custom project and varies on a case-by-case basis.

13.2.12.9 Annual Energy Savings Algorithm

Annual Energy savings are estimated by the program implementer and verified through the MER process.

13.2.12.10 Coincident Peak Demand Savings Algorithm

Coincident peak demand savings are estimated by the program implementer and verified through the MER process.

13.2.12.11 Algorithm Input Values by Measure

Algorithm inputs are estimated by the program implementer and verified through the MER process.

13.2.13 Retro-Commissioning (RCx)

13.2.13.1 Applicability

Retrofit

13.2.13.2 Applicable Programs

This measure is applicable to APS' Solutions for Business programs, which include:

- Large Existing
- New Construction
- Small Business
- Schools

13.2.13.3 Measure Description

This measure is designed to assess the operational and maintenance components of complex HVAC and lighting control systems in existing buildings to develop a strategy to optimize the systems' energy efficiency. Typical tasks include identifying and implementing relatively low-cost operational improvements and documenting these opportunities in a retro-commissioning report.

13.2.13.4 Baseline Equipment Definition

Facilities with a minimum of 25,000 sq ft of conditioned floor space and utilize a chiller. It is strongly recommended that these facilities also utilize a central building automation system (EMS).

13.2.13.5 Efficient Equipment Definition

Retro-commissioning is conducted in three phases:

Phase 1 – Benchmarking: Energy Star Benchmarking
Phase 2 – Evaluation: At a minimum, services involve all of the following activities:

- Review off all applicable equipment sequencing and operating schedules
- Assess the existing condition and operation of economizers.
- Assess current control capability.
- Review and assess maintenance procedures.
- Identify low cost/ no cost repairs.

Phase 3 – Implementation: At a minimum, services involve all of the following activities:

- Implement low cost / no cost repairs as previously identified. This may include replacing components and revising control sequences that fail the assessment.
- Calculate and document kW and kWh savings achieved from these efforts.
- Identify improvements that will require capital investment.

13.2.13.6 Unit Basis

Savings and costs are based on a "per project" basis.

13.2.13.7 Effective Useful Life

The effective useful life is specific to the RCx project and varies on a case-by-case basis.

13.2.13.8 Incremental Measure Cost

The incremental cost is specific to the RCx project and varies on a case-by-case basis.

13.2.13.9 Annual Energy Savings Algorithm

Annual Energy savings are estimated by the program implementer on a case-by-case basis and verified through the MER process.

13.2.13.10 Coincident Peak Demand Savings Algorithm

Coincident peak demand savings are estimated by the program implementer on a case-by-case basis and verified through the MER process.

13.2.13.11 Algorithm Input Values by Measure

Algorithm inputs are estimated by the program implementer on a case-by-case basis and verified through the MER process.

13.2.14 Whole Building

13.2.14.1 Applicability

New Construction

13.2.14.2 Applicable Programs

This measure is applicable to APS' Solutions for Business programs, which includes:

- New Construction

13.2.14.3 Measure Description

This measure encourages design teams and building owners/developers to design and construct highly efficient buildings. The purpose is to promote creative, energy-efficient design strategies at the earliest stages.

13.2.14.4 Baseline Standard Definition

The baseline is a building built according to the ASHRAE 90.1-2007 standard for new buildings.

13.2.14.5 Efficient Standard Definition

The efficient case is a building designed to be at least 10% more efficient than the baseline based on the whole building energy performance.

13.2.14.6 Unit Basis

This measure's savings and incremental measure cost are determined based on a "per sq ft" basis.

13.2.14.7 Effective Useful Life

This measure has an effective useful life of 15 years.

13.2.14.8 Incremental Measure Cost

The incremental cost per sq ft for this measure varies depending on the unit type, unit size and includes the total material and labor costs. Incremental costs are based on two sources: "Energy Performance of LEED for New Construction Buildings[92]" and "Measuring the Cost to Become LEED Certified[93]". For details of specific incremental cost calculations, refer to the MAS.

13.2.14.9 Annual Energy Savings Algorithm

Annual energy savings are based on supporting documentation provided by the customer and verified by the program implementer and evaluation team on a case-by-case basis.

13.2.14.10 Coincident Peak Demand Savings Algorithm

Coincident peak demand savings are based on supporting documentation provided by the customer and verified by the program implementer and evaluation team on a case-by-case basis.

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[92] Energy Performance of LEED for New Construction Buildings, March 2008. http://www.usgbc.org/ShowFile.aspx?DocumentID=3930

[93] Measuring the Cost to Become LEED Certified, November 2008. www.facilitiesnet.com/Green/article/Measuring-The-Cost-To-Become-LEED-Certified--10057

13.2.14.11 Algorithm Input Values by Measure

Model inputs are based on supporting documentation provided by the customer and verified by the program implementer and evaluation team on a case-by-case basis.

14. SOLUTIONS FOR BUSINESS PROGRAM – EXPRESS SOLUTIONS

14.1 Algorithm Input Descriptions

14.1.1 Hours of Operation (OpHrs)

Annual hours of operation for lighting end-use measure types are determined from customer self-reported data on project applications and vary due to different operating conditions for different buildings. These hours are then refined and assessed against results of a metering study conducted in 2012. Annual hours of operation for refrigeration end-use measure types vary depending on the equipment's application.

14.1.2 Baseline Wattage of Fixture (W_{base})

Baseline wattages of fixtures are derived from the program implementer's fixture wattage table, shown in Table 14-1, which contains records of common lighting fixture configurations and wattages according to lamp length, lamp size, and ballast type. Contractors for the Express Solutions Program may choose from any fixture listed in the table as the baseline wattage.

14.1.3 Efficient Wattage of Fixture (W_{EE})

Efficient wattages of fixtures are derived from the program implementer's fixture wattage table, shown in Table 14-1, which contains records of common lighting fixture configurations and wattages according to lamp length, lamp size, and ballast type. Contractors for the Express Solutions Program may choose from any fixture listed in the table as the efficient wattage, with the exception of Standard T12s, halogens, and incandescents.

14.1.4 Demand Interaction Factor (DIF)

The demand interaction factor is used to account for the fraction of the direct measure demand savings that decrease (or increase) HVAC system demand. For instance, the installation of more efficient lighting systems in conditioned spaces reduce cooling loads and increase heating loads in conditioned spaces resulting in reduced usage of the HVAC system during peak periods of the summer. Demand interaction factors for different building types are determined through calibrated building simulation utilizing TMY weather data for Phoenix, AZ.

14.1.5 Energy Interaction Factor (EIF)

The energy interaction factor is used to account for the fraction of the direct measure energy savings that decrease (or increase) HVAC system consumption. For instance, the installation of more efficient lighting systems reduce cooling loads and increased heating loads in conditioned spaces resulting in reduced usage of the HVAC system during peak periods of the summer. Energy interaction factors for different building types are determined through calibrated building simulation utilizing typical TMY weather data for Phoenix, AZ.

14.1.6 Diversity Factor (DF)

The DF refers to the ratio of the peak demand of a population of units to the sum of the non-coincident peak demands of all individual units and is derived from a field metering study for lighting measures.

14.1.7 Coincidence Factor (CF)

The CF is the fraction of the peak demand of a population that is in operation at the time of APS' system peak and is derived from a field metering study and analysis of APS' system load.

14.1.8 Load Factor (LF)

The LF is the ratio actual load that a compressor or motor normally runs to the rated load of the equipment based on nameplate power/capacity.

14.1.9 Demand Savings Factor (DSF)

The DSF represents the percent savings over baseline energy demand. Values are based on engineering models and secondary literature reviews specific to commercial lighting and refrigeration equipment

14.1.10 Energy Savings Factor (ESF)

The ESF represents the percent savings over baseline energy consumption. Values are based on engineering models and secondary literature reviews specific to commercial lighting and refrigeration equipment

14.1.11 Base Energy Consumption

Base energy consumption reflects annual energy consumption from baseline equipment before the installation of controls or replacement with more efficient equipment. Depending on the specific measure, this value may be applied on a different unit basis (e.g., kWh per LF, kWh per ton). Values are based on engineering models and secondary literature reviews specific to commercial refrigeration equipment.

14.1.12 Base Demand

Base demand reflects the highest load from baseline equipment before the installation of controls or replacement with more efficient equipment. Depending on the specific measure, this value may be applied on a different unit basis (e.g., kW per unit, kBtuh per LF). Values are based on engineering models and secondary literature reviews specific to commercial refrigeration equipment.

14.1.13 Base COP

The Base coefficient of performance (COP) refers to the efficiency for the baseline condition of a commercial refrigeration system.

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14.1.14 EE COP

The EE coefficient of performance (COP) refers to the efficiency for the efficient condition of a commercial refrigeration system.

14.1.15 Duty Cycle (DC)

The duty cycle refers to the percent of time a compressor operates to meet the required cooling load. Values are based on engineering models and secondary literature reviews specific to commercial refrigeration equipment.

Table 14-1. Express Solutions Lighting Fixture Wattage Table

Equipment Type	Fixture Description	Watts
Exit Sign (LED)	Single Face Electroluminescent Exit Sign	1
Exit Sign (LED)	Double Face Electroluminescent Exit Sign	2
Exit Sign (LED)	Single Face LED Exit Sign	2.5
Exit Sign (LED)	LED Exit Sign Replacement	5
Exit Sign (LED)	LED Exit Sign Replacement w/ Spot Lights	5
Exit Sign (LED)	LED Retrofit kit	5
Exit Sign (CFL)	5W Compact Fluorescent Exit Sign - Hardwired	7
Exit Sign (CFL)	5W Compact Fluorescent Exit Sign - Screw-in	7
Exit Sign (CFL)	7W Compact Fluorescent Exit Sign - Hardwired	9
Exit Sign (CFL)	7W Compact Fluorescent Exit Sign - Screw-in	9
Exit Sign (CFL)	"Whip" Exit Sign	10
Exit Sign (CFL)	9W Compact Fluorescent Exit Sign - Hardwired	11
Exit Sign (CFL)	9W Compact Fluorescent Exit Sign - Screw-in	11
Exit Sign (CFL)	11W Compact Fluorescent Exit Sign - Hardwired	14
Exit Sign (CFL)	11W Compact Fluorescent Exit Sign - Screw-in	14
Exit Sign (CFL)	Exit Sign - (2) 5W Comp Fluor	14
Exit Sign (Incandescent)	Standard 25W Incandescent Exit Sign	25
Exit Sign (Incandescent)	Standard 30W Incandescent Exit Sign	30
Exit Sign (Incandescent)	Standard (2) 20W Incandescent Exit Sign	40
Exit Sign (Incandescent)	Standard (2) 25W Incandescent Exit Sign	50
Exit Sign (Incandescent)	Standard (2)40W Incandescent Exit Sign	80
Hardwired CFL	7W Comp Fluor / Hardwired	7
Hardwired CFL	11W Comp Fluor / Hardwired	11
Hardwired CFL	13W Comp Fluor / Hardwired	13
Hardwired CFL	15 W Comp Fluor Canopy	15

Hardwired CFL	15 W Comp Fluor Drum	15
Hardwired CFL	15 W Comp Fluor / Hardwired	15
Hardwired CFL	15 W Comp Fluor Wallpack	15
Hardwired CFL	5-13 W CFL (Hardwired)	15
Hardwired CFL	18 W Comp Fluor / Hardwired	18
Hardwired CFL	23 W Comp Fluor Canopy	23
Hardwired CFL	23 W Comp Fluor / Hardwired	23
Hardwired CFL	23 W Comp Fluor Wallpack	23
Hardwired CFL	22W Circline Lamp / Hardwired	24
Hardwired CFL	14-26 W CFL (Hardwired)	26
Hardwired CFL	26 W Comp Fluor / Hardwired	26
Hardwired CFL	28W Comp Fluor / Hardwired	30
Hardwired CFL	30 W Comp Fluor Canopy	30
Hardwired CFL	30 W Comp Fluor Wallpack	30
Hardwired CFL	32W Circline Lamp / Hardwired	34
Hardwired CFL	36 W Comp Fluor Hardwired Lamp	36
Hardwired CFL	42 W Comp Fluor Canopy	42
Hardwired CFL	42 W Comp Fluor Wallpack	42
Hardwired CFL	27-65 W CFL (Hardwired)	45
Hardwired CFL	55 W Comp Fluor Hardwired T-5	55
Hardwired CFL	66-90 W CFL (Hardwired)	74
Hardwired CFL	>90 W CFL (Hardwired)	123
Incandescent/ Halogen	25 Watt Incandescent Lamp	25
Incandescent/ Halogen	40 Watt PAR Halogen	40
Incandescent/ Halogen	40 Watt Incandescent Lamp	40
Incandescent/ Halogen	50 Watt Incandescent Lamp	50
Incandescent/ Halogen	60 Watt Incandescent Fixture	60
Incandescent/ Halogen	60 Watt PAR Halogen	60
Incandescent/ Halogen	60 Watt Incandescent Lamp	60
Incandescent/ Halogen	65 Watt PAR Incandescent	65
Incandescent/ Halogen	75 Watt PAR Halogen	75
Incandescent/ Halogen	75 Watt Incandescent Lamp	75
Incandescent/ Halogen	75 Watt PAR Incandescent	75
Incandescent/ Halogen	100 Watt PAR Halogen	100
Incandescent/ Halogen	100 Watt Incandescent Fixture	100
Incandescent/ Halogen	100 Watt Incandescent Lamp	100
Incandescent/ Halogen	150 Watt PAR Halogen	150

Incandescent/ Halogen	150 Watt Incandescent Fixture	150
Incandescent/ Halogen	150 Watt Incandescent Lamp	150
Incandescent/ Halogen	150 Watt PAR Incandescent	150
Incandescent/ Halogen	180 Watt Incandescent Fixture	180
Incandescent/ Halogen	200 Watt PAR Halogen	200
Incandescent/ Halogen	200 Watt Incandescent Lamp	200
Incandescent/ Halogen	225 Watt Incandescent Fixture	200
Incandescent/ Halogen	250 Watt Incandescent Lamp	250
Incandescent/ Halogen	300 Watt PAR Halogen	300
Incandescent/ Halogen	300 Watt Incandescent	300
Incandescent/ Halogen	350 Watt Incandescent Fixture	350
Incandescent/ Halogen	500 Watt PAR Halogen	500
Incandescent/ Halogen	500 Watt Incandescent	500
Incandescent/ Halogen	500 Watt Incandescent Fixture	500
Incandescent/ Halogen	1000 Watt PAR Halogen	1000
Incandescent/ Halogen	1000 Watt Incandescent	1000
Incandescent/ Halogen	1000 Watt Incandescent Fixture	1000
Incandescent/ Halogen	1500 Watt PAR Halogen	1500
T8/T5	1-2' 17W T8 Lamp, LP Elect Ballast	15
T8/T5	1-2' 17W T8 Lamp, LP Elect Ballast(1) & Refl	15
T8/T5	1-2' 17W T8 Lamp, Elect Ballast(1)	18
T8/T5	1-4' 25W T8 Lamp, LP Elect Ballast	20
T8/T5	1-4' 28W T8 Lamp, LP Elect Ballast	22
T8/T5	1-3' 25W T8 Lamp, Elect Ballast w/Ballast Cover	23
T8/T5	1-3' 25W T8 Lamp, LP Elect Ballast(1)	23
T8/T5	1-2' 28W U-shape T8 Lamp, Low Power Elect Ballast(1)	24
T8/T5	1-3' 25W T8 Lamp, Elect Ballast(1)	24
T8/T5	1-4' 25W T8 Lamp, Elect Ballast	24
T8/T5	1-4' 30W T8 Lamp, LP Elect Ballast (1)	27
T8/T5	1-4' 30W T8 Lamp, LP Elect Ballast (1) w/Refl	27
T8/T5	1-4' 28W T8 Lamp, Elect Ballast	28
T8/T5	2-2' 17W T8 Lamp, LP Elect Ballast(1)	29
T8/T5	2-2' 17W T8 Lamp, LP Elect Ballast(1) & Refl	29
T8/T5	1-3' 25W T8 Lamp, HP Elect Ballast(1)	30
T8/T5	1-3' 25W T8 Lamp, HP Elect Ballast(1), Refl	30
T8/T5	1-4' 25W T8 Lamp, HP Elect Ballast	30
T8/T5	1-4' 30W T8 Lamp, Elect Ballast (1)	30

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T8/T5	1-4' 30W T8 Lamp, Elect Ballast (1) w/Refl	30
T8/T5	1-4' 32W T8 Lamp, LP Elect Ballast (1)	30
T8/T5	2-2' 17W T8 Lamp, Low Power Elect Ballast w/refl	30
T8/T5	1-4' 28W T5 Lamp, Elect Ballast	31
T8/T5	1-4' 32W T8 Lamp, Elect Ballast (1)	31
T8/T5	1-4' 32W T8 Lamp, Elect Ballast (1)	31
T8/T5	1-4' 32W T8 Lamp, Elect Ballast w/Ballast Cover	31
T8/T5	2-2' 17W T8 Lamp, Elect Ballast w/refl	31
T8/T5	2-2' 17W T8 Lamp, Elect Ballast(1)	31
T8/T5	2-2' 17W T8 Lamp, Elect Ballast w/Ballast Cover	31
T8/T5	2-2' 17W T8 Lamp, Elect Ballast w/Ballast Cover	31
T8/T5	1-2' 31W U-shape T8 Lamp, Elect Ballast(1)	32
T8/T5	2-2' 17W T8 Lamp, HP Elect Ballast(1)	32
T8/T5	2-2' 17W T8 Lamp, HP Elect Ballast(1) & Refl	32
T8/T5	1-4' 28W T8 Lamp, HP Elect Ballast	35
T8/T5	1-4' 32W T8 Lamp, HP Elect Ballast (1)	38
T8/T5	1-4' 32W T8 Lamp, HP Elect Ballast w/Ballast Cover	38
T8/T5	1-4' 32W T8 Lamp,HP Elect Ballast (1), Refl	38
T8/T5	2-2' 25W U-shape T8 Lamp, Low Power Elect Ballast(1)	40
T8/T5	2-4' 25W T8 Lamp, LP Elect Ballast	40
T8/T5	2-4' 25W T8 Lamp, LP Elect Ballast w/ Ballast Cover	40
T8/T5	2-4' 25W T8 Lamp, LP Elect Ballast w/ Reflector	40
T8/T5	2-3' 25W T8 Lamp, LP Elect Ballast(1)	41
T8/T5	2-3' 25W T8 Lamp, LP Elect Ballast w/Ballast Cover	41
T8/T5	2-2' 28W U-shape T8 Lamp, Low Power Elect Ballast(1)	43
T8/T5	2-4' 28W T8 Lamp, LP Elect Ballast	43
T8/T5	3-2' 17W T8 Lamp, LP Elect Ballast(1)	43
T8/T5	3-2' 17W T8 Lamp, LP Elect Ballast, Refl	43
T8/T5	1-5' 40W T8 Lamp, Elect Ballast(1)	44
T8/T5	2-4' 30W T8 Lamp, LP Elect Ballast (1)	45
T8/T5	2-4' 30W T8 Lamp, LP Elect Ballast (1) w/Refl	45
T8/T5	3-2' 17W T8 Lamp, Elect Ballast(1)	45
T8/T5	2-2' 25W U-shape T8 Lamp, Elect Ballast(1)	46
T8/T5	2-3' 25W T8 Lamp, Elect Ballast(1)	46
T8/T5	2-3' 25W T8 Lamp, Elect Ballast w/Ballast Cover	46
T8/T5	2-4' 25W T8 Lamp, Elect Ballast	46

T8/T5	2-4' 25W T8 Lamp, Elect Ballast w/ Ballast Cover	46
T8/T5	2-4' 25W T8 Lamp, Elect Ballast, Refl	46
T8/T5	2-3' 25W T8 Lamp, HP Elect Ballast(1)	47
T8/T5	2-3' 25W T8 Lamp, HP Elect Ballast w/Ballast Cover	47
T8/T5	2-3' 25W T8 Lamp, HP Elect Ballast (1), Refl	47
T8/T5	3-2' 17W T8 Lamp, HP Elect Ballast(1)	48
T8/T5	3-2' 17W T8 Lamp, HP Elect Ballast(1), Refl	48
T8/T5	2-2' 32W U-shape T8 Lamp, Low Power Elect Ballast(1)	51
T8/T5	2-4' 32W T8 Lamp, LP Elect Ballast 8' Retrokit	51
T8/T5	2-4' 32W T8 Lamp, Low Power Elect Ballast (1)	51
T8/T5	2-4' 32W T8 Lamp, Low Power Elect Ballast w/Refl	51
T8/T5	2-4' 32W T8 Lamp, LP Elect Ballast w/Ballast Cover	51
T8/T5	2-4' 30W T8 Lamp, Elect Ballast (1)	54
T8/T5	2-4' 30W T8 Lamp, Elect Ballast (1) w/Refl	54
T8/T5	2-4' 28W T8 Lamp, Elect Ballast	55
T8/T5	2-4' 28W T8 Lamp, Elect Ballast w/ Ballast Cover	55
T8/T5	2-4' 28W T8 Lamp, Elect Ballast(1) & Refl	55
T8/T5	2-4' 32W T8 Lamp, Elect Ballast w/Refl	58
T8/T5	2-4' 32W T8 Lamp, Elect Ballast (1)	58
T8/T5	2-4' 32W T8 Lamp, Elect Ballast (1)	58
T8/T5	2-4' 32W T8 Lamp, Elect Ballast w/Ballast Cover	58
T8/T5	2-4' 32W T8 Lamp, Elect Ballast 8' Retrokit	58
T8/T5	1-4' 54W T5HO Lamp, Elect Ballast	59
T8/T5	1-4' 54W T5HO Lamp, Elect Ballast, Refl	59
T8/T5	1-8' 59W T8 Lamp, LP Elect Ballast(1)	60
T8/T5	2-2' 32W U-shape T8 Lamp, Elect Ballast(1)	60
T8/T5	2-2' 32W U-shape T8 Lamp, Elect Ballast(1)	60
T8/T5	2-4' 25W T8 Lamp, HP Elect Ballast	60
T8/T5	2-4' 28W T5 Lamp, Elect Ballast	60
T8/T5	3-3' 25W T8 Lamp LP Elect Ballast (1)	60
T8/T5	3-3' 25W T8 Lamp, LP Elect Ballast w/Ballast Cover	60
T8/T5	3-4' 25W T8 Lamp, LP Elect Ballast	60
T8/T5	2-2' 31W U-shape T8 Lamp, Elect Ballast(1)	62
T8/T5	3-3' 25W T8 Lamp Elect Ballast (1)	62
T8/T5	4-2' 17W T8 Lamp, Elect Ballast(1)	62
T8/T5	3-4' 28W T8 Lamp, LP Elect Ballast	64

T8/T5	3-4' 28W T8 Lamp, LP Elect Ballast(1) & Refl	64
T8/T5	2-4' 28W T8 Lamp, HP Elect Ballast	65
T8/T5	3-4' 30W T8 Lamp, LP Elect Ballast (1)	67
T8/T5	3-4' 30W T8 Lamp, LP Elect Ballast (1) w/Refl	67
T8/T5	1-6' 35W T8 Lamp, Elect Ballast	68
T8/T5	1-6' 35W T8 Lamp, Elect Ballast, Refl	68
T8/T5	1-8' 59W T8 Lamp, Elect Ballast(1)	68
T8/T5	1-8' 59W T8 Lamp, Elect Ballast (1)	68
T8/T5	3-3' 25W T8 Lamp, HP Elect Ballast(1)	68
T8/T5	3-3' 25W T8 Lamp, HP Elect Ballast (1), Refl	68
T8/T5	3-4' 25W T8 Lamp, Elect Ballast	70
T8/T5	3-4' 25W T8 Lamp, Elect Ballast w/ Ballast Cover	70
T8/T5	3-4' 25W T8 Lamp, Elect Ballast, Refl	70
T8/T5	1-8' 59W T8 Lamp, HP Elect Ballast(1)	71
T8/T5	1-8' 59W T8 Lamp, HP Elect Ballast(1), Refl	71
T8/T5	2-5' 40W T8 Lamp, Elect Ballast(1)	73
T8/T5	2-4' 32W T8 Lamp, High Power Elect Ballast (1)	76
T8/T5	2-4' 32W T8 Lamp, HP Elect Ballast w/Ballast Cover	76
T8/T5	2-4' 32W T8 Lamp, HP Elect Ballast (1), Refl	76
T8/T5	3-4' 32W T8 Lamp, LP Elect Ballast (1)	77
T8/T5	3-4' 32W T8 Lamp, LP Elect Ballast w/Ballast Cover	77
T8/T5	3-4' 28W T8 Lamp, Elect Ballast	78
T8/T5	4-3' 25W T8 Lamp, LP Elect Ballast(1)	80
T8/T5	4-3' 25W T8 Lamp, LP Elect Ballast w/Ballast Cover	80
T8/T5	4-4' 25W T8 Lamp, LP Elect Ballast	80
T8/T5	4-4' 25W T8 Lamp, LP Elect Ballast w/ Ballast Cover	80
T8/T5	4-4' 25W T8 Lamp, LP Elect Ballast w/ Reflector	80
T8/T5	3-4' 30W T8 Lamp, Elect Ballast (1)	81
T8/T5	3-4' 30W T8 Lamp, Elect Ballast (1) w/Refl	81
T8/T5	3-4' 32W T8 Lamp, Elect Ballast w/Refl 8' Retrokit	83
T8/T5	3-4' 32W T8 Lamp, Elect Ballast (1)	83
T8/T5	3-4' 32W T8 Lamp, Elect Ballast (1)	83
T8/T5	3-4' 32W T8 Lamp, Elect Ballast w/Ballast Cover	83
T8/T5	3-4' 32W T8 Lamp, Elect Ballast w/Reflector	83
T8/T5	4-3' 25W T8 Lamp, Elect Ballast(1)	83
T8/T5	4-3' 25W T8 Lamp, Elect Ballast w/Ballast Cover	83

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T8/T5	4-4' 28W T8 Lamp, LP Elect Ballast	86
T8/T5	4-4' 30W T8 Lamp, LP Elect Ballast (1)	89
T8/T5	4-4' 30W T8 Lamp, LP Elect Ballast (1) w/Refl	89
T8/T5	2-6' 35W T8 Lamp, Elect Ballast	90
T8/T5	3-4' 25W T8 Lamp, HP Elect Ballast	90
T8/T5	4-3' 25W T8 Lamp, HP Elect Ballast(1)	90
T8/T5	4-4' 25W T8 Lamp, Elect Ballast	90
T8/T5	3-4' 32W T8 Lamp, HPElect Ballast (1)	92
T8/T5	3-4' 32W T8 Lamp, HP Elect Ballast (1), Refl	92
T8/T5	3-4' 28W T5 Lamp, Elect Ballast	95
T8/T5	2-8' 59W T8 Lamp, LP Elect Ballast(1)	98
T8/T5	3-4' 28W T8 Lamp, HP Elect Ballast	98
T8/T5	3-4' 32W T8 Lamp, HP Elect Ballast (2)	98
T8/T5	4-4' 32W T8 Lamp, LP Elect Ballast 8' Retrokit	100
T8/T5	4-4' 32W T8 Lamp, LP Elect Ballast New Fixture	100
T8/T5	4-4' 32W T8 Lamp, LP Elect Ballast	100
T8/T5	4-4' 32W T8 Lamp, LP Elect Ballast w/Ballast Cover	100
T8/T5	4-4' 28W T8 Lamp, Elect Ballast	104
T8/T5	4-4' 28W T8 Lamp, Elect Ballast w/ Ballast Cover	104
T8/T5	4-4' 30W T8 Lamp, Elect Ballast (1)	107
T8/T5	4-4' 30W T8 Lamp, Elect Ballast (1) w/Refl	107
T8/T5	3-5' 40W T8 Lamp, Elect Ballast(1)	108
T8/T5	2-8' 59W T8 Lamp, Elect Ballast(1)	109
T8/T5	2-8' 59W T8 Lamp, Elect Ballast (1)	109
T8/T5	2-8' 59W T8 Lamp, Elect Ballast(1), Refl	109
T8/T5	4-4' 32W T8 Lamp, Elect Ballast 8' Retrokit	114
T8/T5	4-4' 32W T8 Lamp, Elect Ballast New Fixture	114
T8/T5	4-4' 32W T8 Lamp, Elect Ballast (1)	114
T8/T5	4-4' 32W T8 Lamp, Elect Ballast (1)	114
T8/T5	4-4' 32W T8 Lamp, Elect Ballast w/Ballast Cover	114
T8/T5	2-4' 54W T5HO Lamp, Elect Ballast	117
T8/T5	2 -8' 59W T8 Lamp, HP Elect Ballast(1)	118
T8/T5	2 -8' 59W T8 Lamp, HP Elect Ballast(1), Refl	118
T8/T5	4-4' 25W T8 Lamp, HP Elect Ballast	120
T8/T5	4-4' 28W T5 Lamp, Elect Ballast	120
T8/T5	4-4' 28W T8 Lamp, HP Elect Ballast	130

T8/T5	4-4' 32W T8 Lamp, HP Elect Ballast (1)	144
T8/T5	4-4' 32W T8 Lamp, HP Elect Ballast w/Ballast Cover	144
T8/T5	4-4' 32W T8 Lamp, HP Elect Ballast(1), Refl	144
T8/T5	4-4' 32W T8 Lamp, HP Elect Ballast (2)	152
T8/T5	6-4' 32W T8 Lamp, LP Elect Ballast (2)	154
T8/T5	6-4' 32W T8 Lamp, LP Elect Ballast(2) w/ Ballast Cover	154
T8/T5	3 -8' 59W T8 Lamp, LP Elect Ballast(2)	166
T8/T5	6-4' 32W T8 Lamp, Elect Ballast (2) New Fixture	166
T8/T5	6-4' 32W T8 Lamp, Elect Ballast (2)	166
T8/T5	3 -8' 59W T8 Lamp, Elect Ballast(2)	170
T8/T5	6-4' 32W T8 Lamp, HP Elect Ballast w/ refl	184
T8/T5	6-4' 32W T8 Lamp, HP Elect Ballast (2)	184
T8/T5	3 -8' 59W T8 Lamp, HP Elect Ballast(2)	191
T8/T5	3-8' 59W T8 Lamp, HP Elect Ballast(2), Refl	191
T8/T5	8-4' 32W T8 Lamp, LP Elect Ballast(2)	200
T8/T5	8-4' 32W T8 Lamp, LP Elect Ballast(2) w/ Ballast Cover	200
T8/T5	4 -8' 59W T8 Lamp, LP Elect Ballast(2)	208
T8/T5	4 -8' 59W T8 Lamp, Elect Ballast(2)	218
T8/T5	(6) 40W twin-tube T5 with 1 electronic ballast	228
T8/T5	8-4' 32W T8 Lamp, Elect Ballast (2)	228
T8/T5	4-4' 54W T5HO Lamp, Elect Ballast	234
T8/T5	4 -8' 59W T8 Lamp, HP Elect Ballast(2)	236
T8/T5	8-4' 32W T8 Lamp, HP Elect Ballast (2)	240
T8/T5	6-4' 54W T5HO Lamp, Elect Ballast (3)	351
T8/T5	4-5' 40W T8 Lamp, Elect Ballast(2)	360
Screw-in CFL	7W GU24 Comp Fluor / Screw-in Locking Base	7
Screw-in CFL	7W Comp Fluor / Screw-in	7
Screw-in CFL	7W Comp Fluor / Screw-in/ Reflector	7
Screw-in CFL	9W Comp Fluor / Screw-in	9
Screw-in CFL	11W GU24 Comp Fluor / Screw-in Locking Base	11
Screw-in CFL	11W Comp Fluor / Screw-in	11
Screw-in CFL	11W Comp Fluor / Screw-in/ Reflector	11
Screw-in CFL	13W GU24 Comp Fluor / Screw-in Locking Base	13
Screw-in CFL	13W Comp Fluor / Screw-in	13
Screw-in CFL	13W Comp Fluor / Screw-in/ Reflector	13
Screw-in CFL	5-15 W CFL (Screw In)	13.5

Screw-in CFL	5-15 W CFL (Screw In) w/ Reflector	13.5
Screw-in CFL	5-15 W GU24 Comp Fluor / Screw-in Locking Base	13.5
Screw-in CFL	5-15 W CFL GU24 w/ Reflector	13.5
Screw-in CFL	15W GU24 Comp Fluor / Screw-in Locking Base	15
Screw-in CFL	15W Comp Fluor / Screw-in	15
Screw-in CFL	15W Comp Fluor / Screw-in / Reflector	15
Screw-in CFL	18W GU24 Comp Fluor / Screw-in Locking Base	18
Screw-in CFL	18W Comp Fluor / Screw-in	18
Screw-in CFL	18W Comp Fluor / Screw-in/ Reflector	18
Screw-in CFL	16-25 W CFL (Screw In)	19
Screw-in CFL	16-25 W CFL (Screw In) w/ Reflector	19
Screw-in CFL	16-25 W CFL GU24 w/ Reflector	19
Screw-in CFL	16-25 W GU24 Comp Fluor / Screw-in Locking Base	22
Screw-in CFL	23 W Comp Fluor Drum	23
Screw-in CFL	23W GU24 Comp Fluor / Screw-in Locking Base	23
Screw-in CFL	23W Comp Fluor / Screw-in	23
Screw-in CFL	23W Comp Fluor / Screw-in/Reflector	23
Screw-in CFL	22W Circline Lamp / Screw-in	25
Screw-in CFL	26W GU24 Comp Fluor / Screw-in Locking Base	26
Screw-in CFL	26 W Comp Fluor / Screw-in	26
Screw-in CFL	26 W Comp Fluor / Screw-in/Reflector	26
Screw-in CFL	27W Circline Lamp / Screw-in	27
Screw-in CFL	26-35 W CFL (Screw In)	28
Screw-in CFL	26-35 W CFL (Screw In) w/ Reflector	28
Screw-in CFL	26-35 W GU24 Comp Fluor / Screw-in Locking Base	28
Screw-in CFL	26-35 W CFL GU24 w/ Reflector	28
Screw-in CFL	28W GU24 Comp Fluor / Screw-in Locking Base	30
Screw-in CFL	28W Comp Fluor / Screw-in	30
Screw-in CFL	28W Comp Fluor/Screw-in / Reflector	30
Screw-in CFL	30 W Comp Fluor Brass Drum	30
Screw-in CFL	30 W Comp Fluor Drum	30
Screw-in CFL	36 W Comp Fluor Screw-in Lamp	36
Screw-in CFL	36-45 W CFL (Screw In)	41
Screw-in CFL	36-45 W CFL (Screw In) w/ Reflector	41
Screw-in CFL	36-45 W GU24 Comp Fluor / Screw-in Locking Base	41
Screw-in CFL	36-45 W CFL GU24 w/ Reflector	41

Screw-in CFL	42 W Comp Fluor Drum	42
Screw-in CFL	42 W Comp Fluor Triple Biax	42
Screw-in CFL	40/30W Biax with 1 ballast	43
Screw-in CFL	40/30W Biax with 1 ballast - screw-in	43
Screw-in CFL	52 W Comp Fluor Fixture	52
Screw-in CFL	>45 W CFL (Screw In)	60
Screw-in CFL	>45 W CFL (Screw In) w/ Reflector	60
Screw-in CFL	>45 W GU24 Comp Fluor / Screw-in Locking Base	60
Screw-in CFL	>45 W CFL GU24 w/ Reflector	60
Screw-in LED	3W R, BR, or PAR series lamps	3
Screw-in LED	5W R, BR, or PAR series lamps	5
Screw-in LED	6W R, BR, or PAR series lamps	6
Screw-in LED	8W R, BR, or PAR series lamps	8
Screw-in LED	13W R, BR, or PAR series lamps	13
Standard T12	1-2' 20W T12s Lamp, Std Ballast(1)	26
Standard T12	1-3' T12s hybrid	37
Standard T12	24-27 W Biax, 1 ballast	37
Standard T12	1-2' 34W U-shape T12s Lamp, Eff Mag Ballast(1)	44
Standard T12	1-2' 34/40W hybrid U-shape T12s	47
Standard T12	1-2' 40W U-shape T12s Lamp, Eff Mag Ballast(1)	50
Standard T12	1-4' 34/40W hybrid	50
Standard T12	2-2' T12s hybrid	51
Standard T12	1-5' 50W hybrid	55
Standard T12	1-2' 35W HO T12s Lamp, Std Ballast(1)	62
Standard T12	1-3' 50W T12s HO Lamp, Standard Ballast	70
Standard T12	2-3' 25/30W hybrid	74
Standard T12	2-2' 34/40W U hybrid	75
Standard T12	1-4' HO hybrid	82
Standard T12	1-6' 55W hybrid	82
Standard T12	2-4' 34/40W T12s hybrid	84
Standard T12	4-2' 20W T12s Lamp, Std Ballast(2)	84
Standard T12	1-8' 60/75W hybrid	87
Standard T12	2-2' 35W HO T12s Lamp, Std Ballast(1)	90
Standard T12	1-5' 75W T12sHO Lamp, Standard Ballast(1)	110
Standard T12	1-6' 85W HO hybrid	114
Standard T12	2-3' 50W T12s HO Lamp, StandardBallast	114
Standard T12	3-3' 25W/30W T12s hybrid	115

Standard T12	2-5' 50W T12s Lamp, Standard Ballast(1)	118
Standard T12	2-6' 55W hybrid	118
Standard T12	1-8' HO hybrid	122
Standard T12	3-4' 34/40W hybrid	134
Standard T12	2-4' 60W hybrid	136
Standard T12	2-5' 75W T12sHO Lamp, Electric Ballast(1)	138
Standard T12	2-8' 60/75W hybrid	148
Standard T12	4-3' 25/30W hybrid T12s	148
Standard T12	1-5' 135W T12sVHO Lamp, Standard Ballast(1)	157
Standard T12	4-4' 34/40W hybrid	168
Standard T12	2-6' 85W T12sHO Lamp, Elect Ballast	169
Standard T12	3-5' 50W T12s Lamp, Standard Ballast(2)	178
Standard T12	1-6' 160W T12sVHO Lamp, Standard Ballast	180
Standard T12	2-5' 75W T12sHO Lamp, Standard Ballast(1)	180
Standard T12	2-6' 85W hybrid	193
Standard T12	2-6' 85W T12sHO Lamp, En Eff Mag Ballast	194
Standard T12	2-5' HO hybrid	209
Standard T12	2-6' 85W T12sHO Lamp, Standard Ballast	215
Standard T12	1-8' VHO hybrid	218
Standard T12	2-8' HO hybrid	232
Standard T12	3-8' 60/75W hybrid	238
Standard T12	2-4' 110W hybrid	246
Standard T12	6-4' 34/40W hybrid	253
Standard T12	4-6' 55W T12s Lamp, Standard Ballast (2)	260
Standard T12	4-8' 60/75W hybrid	297
Standard T12	2-5' 135W T12sVHO Lamp, Standard Ballast(1)	310
Standard T12	2-6' 160W T12sVHO Lamp, Standard Ballast	340
Standard T12	3-8' HO hybrid	354
Standard T12	4-5' 50W T12s Lamp, Standard Ballast(2)	360
Standard T12	6-6' 55W T12s Lamp, Std. Ballast (3)	390
Standard T12	2-8' VHO hybrid	418
Standard T12	4-6' 85W T12sHO Lamp, Standard Ballast (2)	430

14.2 Measure Characterizations

14.2.1 Premium T8/T5

14.2.2 Applicability

Retrofit

14.2.2.1 Applicable Programs

This measure is applicable to APS' Solutions for Business Express Solutions Program.

14.2.2.2 Measure Description

Refer to the Solutions for Business measure found in Section 9.2.2

14.2.2.3 Baseline Equipment Definition

Refer to the Solutions for Business measure found in Section 9.2.2

14.2.2.4 Efficient Equipment Definition

Refer to the Solutions for Business measure found in Section 9.2.2

14.2.2.5 Unit Basis

This measure's incentive, savings, and incremental measure cost are determined on a "per lamp" basis.

14.2.2.6 Effective Useful Life

This measure has an effective useful life of 15 years determined from DEER 2008[94].

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[94] http://www.deeresources.com/

14.2.2.7 Incremental Measure Cost

The incremental cost for this measure varies depending on the lamp type and lamp length and includes the total material and labor costs. Incremental costs are derived from contractor interviews and secondary sources. Specific incremental costs for different fixture types can be found in Table 14-2.

14.2.2.8 Annual Energy Savings Algorithm

The following algorithm is used to estimate annual energy saving impacts for this measure. Numeric values for the variables can be found in Table 14-2.

$$\Delta kWh = \frac{(W_{base} - W_{ee})}{1000} \times OpHrs \times (1 + EIF)$$

Where:

ΔkWh	=	Energy savings for measure (in kWh)
W_{base}	=	Baseline Wattage of Fixture
W_{ee}	=	Efficient Wattage of Fixture
OpHrs	=	Hours of Operation
EIF	=	Energy Interaction Factor

14.2.2.9 Coincident Peak Demand Savings Algorithm

The following algorithm is used to estimate annual coincident peak demand saving impacts for this measure. Numeric values for the variables can be found in Table 14-2.

$$\Delta kW_{coincident} = \frac{(W_{base} - W_{ee})}{1000} \times (1 + DIF) \times DF \times CF$$

Where:

$\Delta kW_{coincident}$	=	Coincident peak demand savings for this measure (in kW)
W_{base}	=	Baseline Wattage of Fixture
W_{ee}	=	Efficient Wattage of Fixture
DIF	=	Demand Interaction Factor
DF	=	Diversity Factor
CF	=	Coincidence Factor

14.2.2.10 Algorithm Input Values by Measure

The values presented in the following table are based on historical participation data for the Solutions for Business Express Solutions Program.

Table 14-2. Measure Lookup Values - Premium T8/T5

Measure	OpHrs	W_{base}	W_{EE}	DIF	EIF	CF	DF	Incremental Cost ($/lamp)
T12 to Premium T8/T5	4234	119	62	0.16	0.14	0.73	0.79	$56.66
T8 to Premium T8/T5	4234	73	55	0.16	0.14	0.73	0.79	$55.51

14.2.3 T12 to T8 Delamping

14.2.3.1 Applicability

Retrofit

14.2.3.2 Applicable Programs

This measure is applicable to APS' Solutions for Business Express Solutions Program.

14.2.3.3 Measure Description

Refer to the Solutions for Business measure found in Section 14.2.3

14.2.3.4 Baseline Equipment Definition

Refer to the Solutions for Business measure found in Section 14.2.3

14.2.3.5 Efficient Equipment Definition

Refer to the Solutions for Business measure found in Section 14.2.3

14.2.3.6 Unit Basis

This measure's incentive, savings, and incremental measure cost are determined on a "per lamp" basis.

14.2.3.7 Effective Useful Life

This measure has an effective useful life of 15 years determined from DEER 2008[95].

[95] http://www.deeresources.com/

14.2.3.8 Incremental Measure Cost

The incremental cost for this measure varies depending on the lamp type and lamp length and includes the total material and labor costs. Incremental costs are derived from contractor interviews and secondary sources. Specific incremental costs for different fixture types can be found in Table 14-3.

14.2.3.9 Annual Energy Savings Algorithm

The following algorithm is used to estimate annual energy saving impacts for this measure. Numeric values for the variables can be found in Table 14-3.

$$\Delta kWh = \frac{(W_{base} - W_{ee})}{1000} \times OpHrs \times (1 + EIF)$$

Where:

ΔkWh	=	Energy savings for measure (in kWh)
W_{base}	=	Baseline Wattage of Fixture
W_{ee}	=	Efficient Wattage of Fixture
OpHrs	=	Hours of Operation
EIF	=	Energy Interaction Factor

14.2.3.10 Coincident Peak Demand Savings Algorithm

The following algorithm is used to estimate annual coincident peak demand saving impacts for this measure. Numeric values for the variables can be found in Table 14-3.

$$\Delta kW_{coincident} = \frac{(W_{base} - W_{ee})}{1000} \times (1 + DIF) \times DF \times CF$$

Where:

$\Delta kW_{coincident}$	=	Coincident peak demand savings for this measure (in kW)
W_{base}	=	Baseline Wattage of Fixture
W_{ee}	=	Efficient Wattage of Fixture
DIF	=	Demand Interaction Factor
DF	=	Diversity Factor
CF	=	Coincidence Factor

14.2.3.11 Algorithm Input Values by Measure

The values presented in the following table are based on historical participation data for the Solutions for Business Express Solutions Program.

Table 14-3. Measure Lookup Values - Delamping

Measure	OpHrs	W_{base}	W_{EE}	DIF	EIF	CF	DF	Incremental Cost ($/lamp)
T12 to Premium T8 Delamping	4234	163	47	0.16	0.14	0.73	0.79	$51.97

14.2.4 Screw-In CFL

14.2.4.1 Applicability

Retrofit

14.2.4.2 Applicable Programs

This measure is applicable to APS' Solutions for Business Express Solutions Program.

14.2.4.3 Measure Description

Refer to the Solutions for Business measure found in Section 9.2.5

14.2.4.4 Baseline Equipment Definition

Refer to the Solutions for Business measure found in Section 9.2.5

14.2.4.5 Efficient Equipment Definition

Refer to the Solutions for Business measure found in Section 9.2.5

14.2.4.6 Unit Basis

This measure's incentive, savings, and incremental measure cost are determined on a "per lamp" basis.

14.2.4.7 Effective Useful Life

This measure has an effective useful life of 2 years determined from estimated CFL lifetime and from annual hours of operation.

14.2.4.8 Incremental Measure Cost

The incremental cost for this measure varies depending on the wattages of the CFLs and includes the total material and labor costs. Incremental costs are derived from contractor interviews and secondary sources. Specific incremental costs for different lamp wattages can be found in Table 14-4.

14.2.4.9 Annual Energy Savings Algorithm

The following algorithm is used to estimate annual energy saving impacts for this measure. Numeric values for the variables can be found in Table 14-4.

$$\Delta kWh = \frac{(W_{base} - W_{ee})}{1000} \times OpHrs \times (1 + EIF)$$

Where:

ΔkWh	=	Energy savings for measure (in kWh)
W_{base}	=	Baseline Wattage of Lamp
W_{ee}	=	Efficient Wattage of Lamp
OpHrs	=	Hours of Operation
EIF	=	Energy Interaction Factor

14.2.4.10 Coincident Peak Demand Savings Algorithm

The following algorithm is used to estimate annual coincident peak demand saving impacts for this measure. Numeric values for the variables can be found in Table 14-4.

$$\Delta kW_{coincident} = \frac{(W_{base} - W_{ee})}{1000} \times (1 + DIF) \times DF \times CF$$

Where:

$\Delta kW_{coincident}$	=	Coincident peak demand savings for this measure (in kW)
W_{base}	=	Baseline Wattage of Lamp
W_{ee}	=	Efficient Wattage of Lamp
DIF	=	Demand Interaction Factor
DF	=	Diversity Factor
CF	=	Coincidence Factor

14.2.4.11 Algorithm Input Values by Measure

The values presented in the following table are based on historical participation data for the Solutions for Business Express Solutions Program.

Table 14-4. Measure Lookup Values - Screw-In CFL

Measure	OpHrs	W_{base}	W_{EE}	DIF	EIF	CF	DF	Incremental Cost ($/lamp)
Screw-In CFL	3987	68	16	0.19	0.16	0.73	0.79	4.83

14.2.5 Hardwired CFL

14.2.5.1 Applicability

Retrofit

14.2.5.2 Applicable Programs

This measure is applicable to APS' Solutions for Business Express Solutions Program.

14.2.5.3 Measure Description

Refer to the Solutions for Business measure found in Section 9.2.6

14.2.5.4 Baseline Equipment Definition

Refer to the Solutions for Business measure found in Section 9.2.6

14.2.5.5 Efficient Equipment Definition

Refer to the Solutions for Business measure found in Section 9.2.6

14.2.5.6 Unit Basis

This measure's incentive, savings, and incremental measure cost are determined on a "per fixture" basis.

14.2.6 Effective Useful Life

This measure has an effective useful life of 12 years determined from estimated CFL lifetime and from annual hours of operation.

14.2.7 Incremental Measure Cost

The incremental cost for this measure varies depending on the type of efficient exit sign being installed and includes the total material and labor costs. Incremental costs are derived from contractor interviews and secondary sources. Specific incremental costs for different exit signs can be found in Table 14-5.

14.2.8 Annual Energy Savings Algorithm

The following algorithm is used to estimate annual energy saving impacts for this measure. Numeric values for the variables can be found in Table 14-5.

$$\Delta kWh = \frac{(W_{base} - W_{ee})}{1000} \times OpHrs \times (1 + EIF)$$

Where:

ΔkWh	=	Energy savings for measure (in kWh)
W_{base}	=	Baseline Wattage of Fixture
W_{ee}	=	Efficient Wattage of Fixture
OpHrs	=	Hours of Operation
EIF	=	Energy Interaction Factor

14.2.9 Coincident Peak Demand Savings Algorithm

The following algorithm is used to estimate annual coincident peak demand saving impacts for this measure. Numeric values for the variables can be found in Table 14-5.

$$\Delta kW_{Coincident} = \frac{(W_{base} - W_{ee})}{1000} \times (1 + DIF) \times DF \times CF$$

Where:

$\Delta kW_{coincident}$	=	Coincident peak demand savings for this measure (in kW)
W_{base}	=	Baseline Wattage of Fixture
W_{ee}	=	Efficient Wattage of Fixture
DIF	=	Demand Interaction Factor
DF	=	Diversity Factor
CF	=	Coincidence Factor

14.2.10 Algorithm Input Values by Measure

The values presented in the following table are based on historical participation data for the Solutions for Business Express Solutions Program.

Table 14-5. Measure Lookup Values - Hardwired CFL

Measure	OpHrs	W_{base}	W_{EE}	DIF	EIF	CF	DF	Incremental Cost ($/fixture)
Hardwired CFL	3987	62	15	0.19	0.16	0.73	0.79	$95.65

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14.2.11 Screw-in LEDs (LED Lamps)

14.2.11.1 Applicability

Retrofit

14.2.11.2 Applicable Programs

This measure is applicable to APS' Solutions for Business Express Solutions Program.

14.2.11.3 Measure Description

Refer to Solutions for Business Section 9.2.16

14.2.11.4 Baseline Equipment Definition

Refer to Solutions for Business Section 9.2.16

14.2.11.5 Efficient Equipment Definition

Refer to Solutions for Business Section 9.2.16

14.2.11.6 Unit Basis

This measure's incentive, savings, and incremental measure cost are determined on a "per lamp" basis.

14.2.11.7 Effective Useful Life

This measure has an effective useful life of 7 years based on estimated LED lifetime and from annual hours of operation.

14.2.11.8 Incremental Measure Cost

The incremental cost for this measure, which only includes total material costs, varies depending on wattages of different LED lamps and whether such lamps have reflectors. Incremental costs are derived from contractor interviews and secondary sources. Specific incremental costs can be found in Table 14-6.

14.2.11.9 Annual Energy Savings Algorithm

The following algorithm is used to estimate annual energy saving impacts for this measure. Numeric values for the variables can be found in Table 14-6.

$$\Delta kWh = \frac{(W_{base} - W_{ee})}{1000} \times OpHours \times (1 + HIF)$$

Where:

ΔkWh	=	Energy savings for measure (in kWh)
W_{base}	=	Baseline Wattage of Lamp

W_{ee}	=	Efficient Wattage of Lamp
OpHrs	=	Hours of Operation
EIF	=	Energy Interaction Factor

14.2.11.10 Coincident Peak Demand Savings Algorithm

The following algorithm is used to estimate annual coincident peak demand saving impacts for this measure. Numeric values for the variables can be found in Table 14-6.

$$\Delta kW_{Coincident} = \frac{(W_{base} - W_{ee})}{1000} \times (1 + DIF) \times DF \times CF$$

Where:

$\Delta kW_{coincident}$	=	Coincident peak demand savings for this measure (in kW)
W_{base}	=	Baseline Wattage of Lamp
W_{ee}	=	Efficient Wattage of Lamp
DIF	=	Demand Interaction Factor
DF	=	Diversity Factor
CF	=	Coincidence Factor

14.2.11.11 Algorithm Input Values by Measure

The values presented in the following table are based on historical participation data for the Solutions for Business programs.

Table 14-6. Measure Lookup Values – Screw-In LED

Measure	OpHrs	W_{base}	W_{EE}	DIF	EIF	CF	Incremental Cost ($/lamp)
Screw-In LED	3676	55	10	0.20	0.17	0.71	34.26

14.2.12 Exit Signs

14.2.12.1 Applicability

Retrofit

14.2.12.2 Applicable Programs

This measure is applicable to APS' Solutions for Business Express Solutions Program.

14.2.12.3 Measure Description

Refer to the Solutions for Business measure found in Section 9.2.7

14.2.12.4 Baseline Equipment Definition

Refer to the Solutions for Business measure found in Section 9.2.7

14.2.12.5 Efficient Equipment Definition

Refer to the Solutions for Business measure found in Section 9.2.7

14.2.12.6 Unit Basis

This measure's incentive, savings, and incremental measure cost are determined on a "per exit sign" basis.

14.2.12.7 Effective Useful Life

This measure has an effective useful life of 16 years determined from DEER 2008[96].

14.2.12.8 Incremental Measure Cost

The incremental cost for this measure varies depending on the wattages of the CFLs and includes the total material and labor costs. Incremental costs are derived from contractor interviews and secondary sources. Specific incremental costs for different lamp wattages can be found in Table 14-7.

14.2.12.9 Annual Energy Savings Algorithm

The following algorithm is used to estimate annual energy saving impacts for this measure. Numeric values for the variables can be found in Table 14-7.

$$\Delta kWh = \frac{(W_{base} - W_{ee})}{1000} \times OpHrs \times (1 + HIF)$$

Where:

ΔkWh	=	Energy savings for measure (in kWh)
W_{base}	=	Baseline Wattage of Fixture
W_{ee}	=	Efficient Wattage of Fixture

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OpHrs	=	Hours of Operation
EIF	=	Energy Interaction Factor

14.2.12.10 Coincident Peak Demand Savings Algorithm

The following algorithm is used to estimate annual coincident peak demand saving impacts for this measure. Numeric values for the variables can be found in Table 14-7.

$$\Delta kW_{coincident} = \frac{(W_{base} - W_{ee})}{1000} x(1 + DIF)xDFxCF$$

Where:

$\Delta kW_{coincident}$	=	Coincident peak demand savings for this measure (in kW)
W_{base}	=	Baseline Wattage of Fixture
W_{ee}	=	Efficient Wattage of Fixture
DIF	=	Demand Interaction Factor
DF	=	Diversity Factor
CF	=	Coincidence Factor

14.2.12.11 Algorithm Input Values by Measure

The values presented in the following table are based on historical participation data for the Solutions for Business Express Solutions Program.

Table 14-7. Measure Lookup Values - Exit Signs

Measure	OpHrs	W_{base}	W_{EE}	DIF	EIF	CF	DF	Incremental Cost ($/exit sign)
Exit Signs	8760	56	4	0.16	0.14	1.00	1.00	$58.76

14.2.13 Occupancy Sensors

14.2.13.1 Applicability

Retrofit and New Construction

14.2.13.2 Applicable Programs

This measure is applicable to APS' Solutions for Business Express Solutions Program.

14.2.13.3 Measure Description

Refer to the Solutions for Business measure found in Section 9.2.8

14.2.13.4 Baseline Equipment Definition

Refer to the Solutions for Business measure found in Section 9.2.8

14.2.13.5 Efficient Equipment Definition

Refer to the Solutions for Business measure found in Section 9.2.8

14.2.13.6 Unit Basis

This measure's incentive is based on a "per connected watts" basis, whereas the measure's savings and incremental measure cost are determined on a "per sensor" basis.

14.2.13.7 Effective Useful Life

This measure has an effective useful life of 8 years determined from DEER 2008[97].

14.2.13.8 Incremental Measure Cost

The incremental cost for this measure varies depending on the number of sensors installed and includes the total material and labor costs. Incremental costs are derived from contractor interviews and secondary sources. Specific incremental costs for different lamp wattages can be found in Table 14-8.

14.2.13.9 Annual Energy Savings Algorithm

The following algorithm is used to estimate annual energy saving impacts for this measure. Numeric values for the variables can be found in Table 14-8.

$$\Delta kWh = \frac{W_{CL} \times OpHrs}{1000} \times (1 + EIF) \times ESF$$

Where:

ΔkWh	=	Energy savings for measure (in kWh)
W_{CL}	=	Connected Load of Lighting Equipment
OpHrs	=	Hours of Operation
EIF	=	Energy Interaction Factor
ESF	=	Energy Savings Factor

14.2.13.10 Coincident Peak Demand Savings Algorithm

The following algorithm is used to estimate annual coincident peak demand saving impacts for this measure. Numeric values for the variables can be found in Table 14-8.

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[97] http://www.deeresources.com/

$$\Delta kW_{coincident} = \frac{W_{CL}}{1000} \times (1 + DIF) \times CF \times DF \times DSF$$

Where:

$\Delta kW_{coincident}$	=	Coincident peak demand savings for this measure (in kW)
W_{CL}	=	Connected Load of Lighting Equipment
DIF	=	Demand Interaction Factor
CF	=	Coincidence Factor
DF	=	Diversity Factor
DSF	=	Demand Savings Factor

14.2.13.11 Algorithm Input Values by Measure

The values presented in the following table are based on historical participation data for the Solutions for Business Express Solutions Program.

Table 14-8. Measure Lookup Values - Occupancy Sensors

Measure	OpHrs	DIF	EIF	DSF	ESF	CF	DF	Incremental Cost ($/sensor)
Occupancy Sensors	8760	0.13	0.12	0.16	0.39	0.73	0.79	$144.57

14.2.14 Vending Machine Reach-in Controls

14.2.14.1 Applicability

Retrofit

14.2.14.2 Applicable Programs

This measure is applicable to APS' Solutions for Business Express Solutions Program.

14.2.14.3 Measure Description

This refrigeration end-use measure promotes the installation of controls with passive infrared occupancy sensors on beverage and snack machines to turn off fluorescent lights and other refrigerated system when the surrounding area is unoccupied for 15 minutes or longer.

14.2.14.4 Baseline Equipment Definition

The baseline case refers to beverage and snack machines' refrigerated systems without occupancy sensor controls.

14.2.14.5 Efficient Equipment Definition

The efficient case refers to beverage and snack machines' refrigerated systems with occupancy sensor controls to turn of fluorescent lights and other refrigerated systems when the surrounding area is unoccupied for 15 minutes or longer.

14.2.14.6 Unit Basis

This measure's incentive, savings, and incremental measure cost are determined on a "per machine" basis for refrigerated display cases.

14.2.14.7 Effective Useful Life

This measure has an effective useful life of 12 years determined from professional judgment.

14.2.14.8 Incremental Measure Cost

The incremental cost for this measure includes the total material and labor costs. Incremental costs are based on interviews with industry experts and secondary sources. Specific incremental costs can be found in Table 14-9.

14.2.14.9 Annual Energy Savings Algorithm

The following algorithm is used to estimate annual energy saving impacts for this measure. Numeric values for the variables can be found in Table 14-9.

$$\Delta kWh = kWh_{base} \times ESF$$

Where:

ΔkWh	=	Energy savings for measure (in kWh)
kWh_{base}	=	Baseline Annual Energy Usage
ESF	=	Energy Savings Factor

14.2.14.10 Coincident Peak Demand Savings Algorithm

The following algorithm is used to estimate annual coincident peak demand saving impacts for this measure. Numeric values for the variables can be found in Table 14-9.

$$\Delta kW_{Coincident} = \frac{kWh_{base}}{LF \times 8760} \times DSF \times CF$$

Where:

$\Delta kW_{coincident}$	=	Coincident peak demand savings for this measure (in kW)
kWh_{base}	=	Baseline Annual Energy Usage
LF	=	Load Factor
DSF	=	Demand Savings Factor

CF = Coincidence Factor

14.2.14.11 Algorithm Input Values by Measure

The values presented in the following table are based on historical participation data for the Solutions for Business Express Solutions Program.

Table 14-9. Measure Lookup Values - Vending Machine Controls

Measure	kWh_{base}	DSF	ESF	CF	LF	Incremental Cost ($/machine)
Beverage Machine Controls	3500	0.23	0.46	0.87	0.60	$192.50
Reach-in Cooler Controls	4000	0.15	.30	0.87	0.60	$168.50
Snack Machine Controls	700	0.23	0.46	0.87	0.60	$87.50

14.2.15 Novelty Case Controller

14.2.15.1 Applicability

Retrofit

14.2.15.2 Applicable Programs

This measure is applicable to APS' Solutions for Business Express Solutions Program.

14.2.15.3 Measure Description

This refrigeration end-use measure promotes the installation of on/off controls on novelty coolers to shut down coolers when a business is closed.

14.2.15.4 Baseline Equipment Definition

The baseline case refers to novelty coolers without on/off controls.

14.2.15.5 Efficient Equipment Definition

The efficient case refers to novelty coolers with on/off controls.

14.2.15.6 Unit Basis

This measure's incentive, savings, and incremental measure cost are determined on a "per controller" basis.

14.2.15.7 Effective Useful Life

This measure has an effective useful life of 12 years determined from professional judgment.

14.2.15.8 Incremental Measure Cost

The incremental cost for this measure includes total material and labor costs, which are derived from contractor interviews and secondary sources. Specific incremental costs can be found in Table 14-10.

14.2.15.9 Annual Energy Savings Algorithm

The following algorithm is used to estimate annual energy saving impacts for this measure. Numeric values for the variables can be found in Table 14-10.

$$\Delta kWh = kWh_{base} \times ESF$$

Where:

ΔkWh	=	Energy savings for measure (in kWh)
kWh_{base}	=	Baseline Annual Energy Usage
ESF	=	Energy Savings Factor

14.2.15.10 Coincident Peak Demand Savings Algorithm

The following algorithm is used to estimate annual coincident peak demand saving impacts for this measure. Numeric values for the variables can be found in Table 14-10.

$$\Delta kW_{coincident} = \frac{kWh_{base}}{LF \times 8760} \times DSF \times CF$$

Where:

$\Delta kW_{coincident}$	=	Coincident peak demand savings for this measure (in kW)
kWh_{base}	=	Baseline Annual Energy Usage
LF	=	Load Factor
DSF	=	Demand Savings Factor
CF	=	Coincidence Factor

14.2.15.11 Algorithm Input Values by Measure

The values presented in the following table are based on historical participation data for the Solutions for Business Express Solutions Program.

Table 14-10. Measure Lookup Values - Novelty Case Controls

Measure	kWh_{base}	DSF	ESF	CF	LF	Incremental Cost ($/machine)
Novelty Case Controller	6567	0.00	0.20	0.87	0.60	$325.00

14.2.16 Anti-Sweat Heater Controls

14.2.16.1 Applicability

Retrofit

14.2.16.2 Applicable Programs

This measure is applicable to APS' Solutions for Business Express Solutions Program.

14.2.16.3 Measure Description

Refer to the Solutions for Business measure found in Section 12.2.1

14.2.16.4 Baseline Equipment Definition

Refer to the Solutions for Business measure found in Section 12.2.1

14.2.16.5 Efficient Equipment Definition

Refer to the Solutions for Business measure found in Section 12.2.1

14.2.16.6 Unit Basis

This measure's incentive, savings, and incremental measure cost are determined on a "per linear foot" basis for refrigerated display cases.

14.2.16.7 Effective Useful Life

This measure has an effective useful life of 12 years determined from DEER 2008[98].

14.2.16.8 Incremental Measure Cost

The incremental cost for this measure includes the total material and labor costs. Incremental costs are based on interviews with industry experts and secondary sources. Specific incremental costs can be found in Table 14-11.

14.2.16.9 Annual Energy Savings Algorithm

The following algorithm is used to estimate annual energy saving impacts for this measure. Numeric values for the variables can be found in Table 14-11.

$$\Delta kWh = kWh_{base} \times ESF \times (1 + IEF)$$

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[98] http://www.deeresources.com/

Where:

ΔkWh	=	Energy savings for measure (in kWh/LF)
kWh_{base}	=	Baseline Energy Usage per LF
ESF	=	Energy Savings Factor
EIF	=	Energy Interaction Factor

14.2.16.10 Coincident Peak Demand Savings Algorithm

The following algorithm is used to estimate annual coincident peak demand saving impacts for this measure. Numeric values for the variables can be found in Table 14-11.

$$\Delta kW_{Coincident} = \frac{kWh_{base} \times DSF \times CF}{8760}$$

Where:

$\Delta kW_{coincident}$	=	Coincident peak demand savings for this measure (in kW/LF)
kWh_{base}		= Baseline Energy Usage per LF
DSF	=	Demand Savings Factor
EIF	=	Energy Interaction Factor
CF	=	Coincidence Factor

14.2.16.11 Algorithm Input Values by Measure

The values presented in the following table are based on historical participation data for the Solutions for Business Express Solutions Program.

Table 14-11. Measure Lookup Values - Anti-Sweat Heater Controls

Measure	kWh_{base}	DSF	ESF	CF	EIF	Incremental Cost ($/LF)
Low Temp Anti-Sweat Heater Controls	1641.6	0.15	0.61	1	0.24	$181.96
High Temp Anti-Sweat Heater Controls	942.4	0.13	0.83	1	0.15	$92.28

14.2.17 Evaporator Fan Motor Controls

14.2.17.1 Applicability

Retrofit

14.2.17.2 Applicable Programs

This measure is applicable to APS' Solutions for Business Express Solutions Program.

14.2.17.3 Measure Description

This refrigeration end-use measure promotes the installation of controls in medium temperature walk-in coolers. The controls vary airflow provided by the evaporator fans as the cooling load changes.

14.2.17.4 Baseline Equipment Definition

The baseline case refers to a walk-in cooler without controls on evaporator fans with electronically commutated motors (ECMs).

14.2.17.5 Efficient Equipment Definition

The efficient case refers to a walk-in cooler with controls on the evaporator fans.

14.2.17.6 Unit Basis

This measure's incentive, savings, and incremental measure cost are determined on a "per motor" basis.

14.2.17.7 Effective Useful Life

This measure has an effective useful life of 12 years determined from professional judgment.

14.2.17.8 Incremental Measure Cost

The incremental cost includes the total material and labor costs, which are based on interviews with industry experts and secondary sources. Specific incremental costs for different motor types can be found in Table 14-12.

14.2.17.9 Annual Energy Savings Algorithm

The following algorithm is used to estimate annual energy saving impacts for this measure. Numeric values for the variables can be found in Table 14-12.

$$\Delta kWh = kWh_{base} \times ESF$$

Where:

ΔkWh	=	Energy savings for measure (in kWh)
kWh_{base}	=	Baseline Annual Energy Use per Motor
ESF	=	Energy Savings Factor

14.2.17.10 Coincident Peak Demand Savings Algorithm

The following algorithm is used to estimate annual coincident peak demand saving impacts for this measure. Numeric values for the variables can be found in Table 14-12.

$$\Delta kW_{Coincident} = \frac{kWh_{base}}{LF \times 8760} \times DSF \times CF$$

Where:

$\Delta kW_{coincident}$	=	Coincident peak demand savings for this measure (in kW)
kWh_{base}	=	Baseline Annual Energy Usage
LF	=	Load Factor
DSF	=	Demand Savings Factor
CF	=	Coincidence Factor

14.2.17.11 Algorithm Input Values by Measure

Table 14-12. Measure Lookup Values - Evaporator Fan Motor Controls

Measure	kWh_{base}	DSF	ESF	CF	LF	Incremental Cost ($/motor)
Evaporator Fan Motor Control	1179	0.00	0.42	0.87	1.00	$245.83

14.2.18 Electronically Commutated Motors

14.2.18.1 Applicability

Retrofit

14.2.18.2 Applicable Programs

This measure is applicable to APS' Solutions for Business Express Solutions Program.

14.2.18.3 Measure Description

This refrigeration end-use measure promotes the replacement of standard-efficiency shaded-pole evaporator fan motors in refrigerated display cases or fan coil in walk-ins with ECMs.

14.2.18.4 Baseline Equipment Definition

The baseline case refers to a refrigerated display case with standard-efficiency shaded pole evaporated fan motors. Existing refrigerated display cases may have existing controls.

14.2.18.5 Efficient Equipment Definition

The efficient case refers to a refrigerated display case with ECMs.

14.2.18.6 Unit Basis

This measure's incentive, savings, and incremental measure cost are determined on a "per motor" basis.

14.2.18.7 Effective Useful Life

This measure has an effective useful life of 12 years determined from professional judgment.

14.2.18.8 Incremental Measure Cost

The incremental cost includes the total material and labor costs, which are based on interviews with industry experts and secondary sources. Specific incremental costs for this measure can be found in Table 14-13.

14.2.18.9 Annual Energy Savings Algorithm

The following algorithm is used to estimate annual energy saving impacts for this measure. Numeric values for the variables can be found in Table 14-13.

$$\Delta kWh = kWh_{base} \times ESF$$

Where:

ΔkWh	=	Energy savings for measure (in kWh)
kWh_{base}	=	Baseline Annual Energy Use per Motor
ESF	=	Energy Savings Factor

14.2.18.10 Coincident Peak Demand Savings Algorithm

The following algorithm is used to estimate annual coincident peak demand saving impacts for this measure. Numeric values for the variables can be found in Table 14-13.

$$\Delta kW_{coincident} = \frac{kWh_{base}}{LF \times 8766} \times DSF \times CF$$

Where:

$\Delta kW_{coincident}$	=	Coincident peak demand savings for this measure (in kW)
kWh_{base}	=	Baseline Annual Energy Usage
LF	=	Load Factor
DSF	=	Demand Savings Factor
CF	=	Coincidence Factor

14.2.18.11 Algorithm Input Values by Measure

The values presented in the following table are based on historical participation data for the Solutions for Business Express Solutions Program.

Table 14-13. Measure Lookup Values - Electronically Commutated Motors

Measure	kWh_{base}	DSF	ESF	CF	LF	Incremental Cost ($/motor)
Evaporator ECMs	2184	0.46	0.46	0.87	1.00	$230.00
Evaporator ECMs only using existing controls	1272	0.46	0.46	0.87	1.00	$230.00

14.2.19 Electronically Commutated Motors and Control

14.2.19.1 Applicability

Retrofit

14.2.19.2 Applicable Programs

This measure is applicable to APS' Solutions for Business Express Solutions Program.

14.2.19.3 Measure Description

This refrigeration end-use measure promotes both the replacement of standard-efficiency shaded-pole evaporator fan motor in refrigerated display cases or fan coil in walk-ins with ECMs and the installation of controls.

14.2.19.4 Baseline Equipment Definition

The baseline case refers to a refrigerated display case with either standard-efficiency shaded pole evaporated fan motors but having no controls.

14.2.19.5 Efficient Equipment Definition

The efficient case refers to a refrigerated display case with ECMs and controls.

14.2.19.6 Unit Basis

This measure's incentive, savings, and incremental measure cost are determined on a "per motor" basis.

14.2.19.7 Effective Useful Life

This measure has an effective useful life of 12 years determined from professional judgment.

14.2.19.8 Incremental Measure Cost

The incremental cost includes the total material and labor costs, which are based on interviews with industry experts and secondary sources. Specific incremental costs for different controls configurations can be found in Table 14-14.

14.2.19.9 Annual Energy Savings Algorithm

The following algorithm is used to estimate annual energy saving impacts for this measure. Numeric values for the variables can be found in Table 14-14.

$$\Delta kWh = kWh_{base} \times ESF$$

Where:

ΔkWh	=	Energy savings for measure (in kWh)
kWh_{base}	=	Baseline Annual Energy Use per Motor
ESF	=	Energy Savings Factor

14.2.19.10 Coincident Peak Demand Savings Algorithm

The following algorithm is used to estimate annual coincident peak demand saving impacts for this measure. Numeric values for the variables can be found in Table 14-14.

$$\Delta kW_{Coincident} = \frac{kWh_{base}}{LF \times 8760} \times DSF \times CF$$

Where:

$\Delta kW_{coincident}$	=	Coincident peak demand savings for this measure (in kW)
kWh_{base}	=	Baseline Annual Energy Usage
LF	=	Load Factor
DSF	=	Demand Savings Factor
CF	=	Coincidence Factor

14.2.19.11 Algorithm Input Values by Measure

The values presented in the following table are based on historical participation data for the Solutions for Business Express Solutions Program.

Table 14-14. Measure Lookup Values - Evaporator ECM and Controls

Measure	kWh_{base}	DSF	ESF	CF	LF	Incremental Cost ($/motor)
Evaporator ECMs & Controls	2184	0.46	0.69	0.87	1.00	$475.83

15. SOLUTIONS FOR BUSINESS PROGRAM – ENERGY INFORMATION SERVICES

15.1 Algorithm Input Descriptions

Savings for the Energy Information Services program are deemed values based on evaluation results and do not employ engineering algorithms.

15.2 Measure Characterizations

15.2.1 Energy Information Services (EIS)

15.2.1.1 Applicability

Retrofit

15.2.1.2 Applicable Programs

This measure is offered through the Energy Information Services (EIS) program under the Solutions for Business umbrella.

15.2.1.3 Measure Description

The EIS Program helps large customers (>100 kW) save energy by giving them a better understanding and control of their facilities' electric use. EIS provides data not only regarding usage and demand, but also identifies when, where and how much power is used in specific areas of each facility. This detailed information allows customers to fine-tune equipment use and operations and to document the impact of those changes.

Participating customers monitor their electric usage through a web-based energy information system that allows them to receive historical (up to previous day) 15-minute usage and demand graphics. This information can be used to improve or monitor energy usage patterns, reduce energy use, reduce demands during on-peak periods and better manage overall energy operations.

15.2.1.4 Baseline Definition

The baseline condition is the operation and electric usage pattern of a customer and/or facility without access to the web-based energy information system.

15.2.1.5 Efficient Definition

The efficient condition is the modified operation and electric usage pattern of a customer and/or facility due to the feedback provided through the web-based energy information system.

15.2.1.6 Unit Basis

This measure's savings and incremental measure cost are normalized on a "per meter installed" basis.

15.2.1.7 Effective Useful Life

This measure has an effective useful life of 5 years based on expected lifetime of various O&M changes discovered through the MER process.

15.2.1.8 Incremental Measure Cost

The incremental cost of installing a single EIS meter to enable the 15-minute interval data is $1225 based on feedback from the program implementer.

15.2.1.9 Annual Energy Savings Algorithm

Program savings are based on in-depth interviews with program participants regarding their modified energy use and operations schedules. Savings were quantified through an analysis of interval meter data sourced from EIS and linked to identifiable actions mentioned in the interviews. The normalized savings are presented in Table 15-1.

15.2.1.10 Coincident Peak Demand Savings Algorithm

Program savings are based on in-depth interviews with program participants regarding their modified energy use and operations schedules. Savings were quantified through an analysis of interval meter data sourced from EIS and linked to identifiable actions mentioned in the interviews. The normalized savings are presented in Table 15-1.

15.3 Algorithm Input Values

Table 15-1. Deemed Savings Values for EIS

Measure	Energy Savings (kWh/meter)	Coincident Peak Demand Savings (kW/meter)	Incremental Cost ($/meter)
Energy Information Services	524	30	$1225.00